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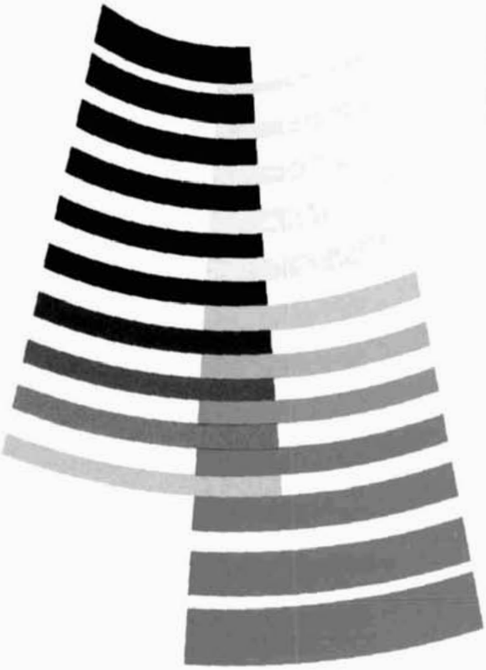

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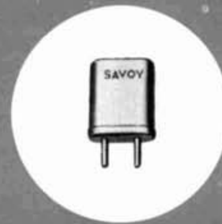

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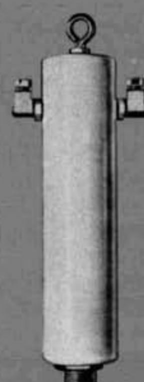

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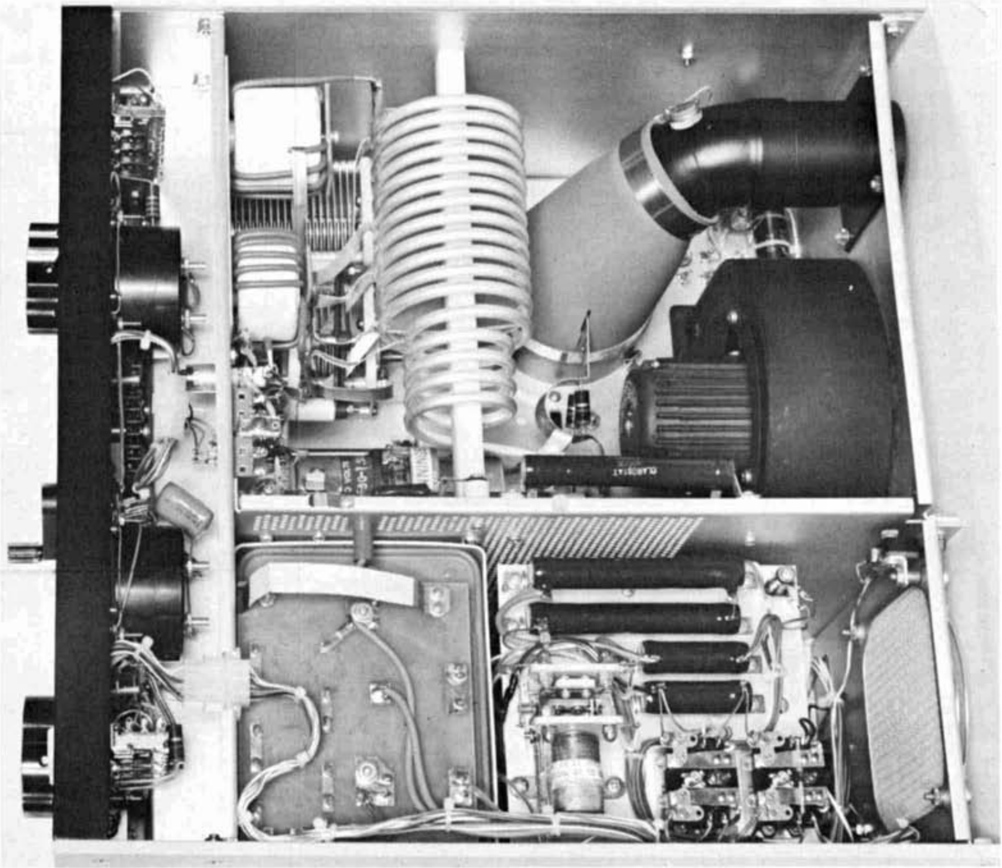

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a second look

by jim fisk

A little over twenty-five years ago, on December 23rd, 1947, to be exact, a group of scientists at Bell Laboratories built a one-stage amplifier circuit around the world's first transistor, giving birth to a whole new era of electronics and communications. But the beginning of the story was not in 1947, but long before. There had been hints of amplification in semiconductors as early as the 1920s but few experimenters could duplicate the results. Nobody realized the effect of semiconductor impurities nor understood the action of semiconductor materials.

In 1930 Dr. Julius Lilienfeld, a German physicist, actually patented a semiconductor amplifier that could be compared to today's mosfet. Although Dr. Lilienfeld's amplifier worked, it could not be duplicated by other workers, and it slowly slipped into oblivion.

In 1939, Dr. William Shockley made an entry into his lab notebook at Bell Labs, "It has today occurred to me that an amplifier using semiconductors rather than vacuum is in principle possible." It was nearly eight years before this concept would bear fruit. A large part of this period was spent in learning more about that old bugaboo, semiconductor impurities.

The 1N21 crystal detector, developed during World War II and the workhorse of wartime radar receivers, provided some of the impetus. After the war a solid-state research team at Bell Labs, co-headed by Dr. Shockley, started experimenting with germanium and silicon, two semiconductors that were easy to work with. As one of the group says today, "We felt that the area was so fertile that you could devise an experiment in the morning, go out in the lab and try it in the afternoon, and then write a paper about it that evening."

The first device the group attempted to build was what is now called an insulated-gate fet. The device didn't work. The group scrambled around, dug into the literature and spent long hours discussing the alternatives.

Dr. Walter Brattain tried an experiment where he covered a metal point with a thin layer of wax and pushed it down on the surface of a piece of silicon. He then surrounded the point with a drop of water and made contact to it. The water was insulated from the point by the wax layer. He found that voltages applied between the water and the silicon would change the current flowing from the silicon to the point. Power amplification had been achieved! Unfortunately, the drop of water would evaporate almost as soon as things were working well.

This led to experiments with other electrolytes that didn't evaporate so readily. Then, they discovered a thin oxide layer on the surface of the semiconductor under the electrolyte and decided to use a spot of gold as a field electrode to eliminate the electrolyte.

When this was tried, an electrical discharge between the point and the gold spoiled a spot in the middle – when they had washed off the electrolyte they had inadvertently washed off the oxide film, which was soluble in water. However, by placing the point around the edge of the gold spot they observed a new effect – when a small positive voltage was applied to the gold, holes flowed in the surface of the semiconductor, greatly increasing the flow of current. Four days later two gold contacts less than two-thousandths of an inch apart were made to the same piece of germanium and the first transistor was born.

Nine years later, in 1956, the three inventors, Dr. William Shockley, Dr. John Bardeen and Dr. Walter Brattain were awarded the Nobel prize in physics. Little did they realize that their crude laboratory device would spawn a multi-billion dollar semiconductor industry that today affects all our lives.

Jim Fisk, W1DTY
editor

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designing communications receivers for good strong-signal performance

Many modern amateur receivers perform poorly in the presence of strong signals — here are some sound design ideas for solving this problem

Ray Moore, 116 Walnut Street, Walpole, Massachusetts 02081

"Current receivers... perform poorly under exactly those conditions that are most important, when the desired signal is weak and the undesired signal is strong" is the way Squires began an article on receiver front-ends in 1963.[1] Since then, solid-state receivers have become the standard in new design, increasing the difficulty of obtaining adequate signal handling characteristics. Outstanding strong-signal performance is one of the more difficult and expensive characteristics to design into a receiver; the least expensive characteristics are sensitivity and gain. This is why most receivers are "hot" enough to rattle the walls on noise alone.

The price for low noise figures on the high-frequency bands is paid, not in dollars, but in poor to mediocre strong-signal performance. Top professional receivers in the \$5000 to \$10000 price range are often designed for noise figures of 10 to 12 dB, the excess noise-figure performance being traded for signal handling ability.

What are the symptons of poor strong-signal performance? Under actual on-the-air conditions a receiver which cannot handle strong signals can have its performance so deteriorated that its static sensitivity and selectivity figures are meaningless. The receiver may go completely silent in the presence of a strong, unwanted station, or its gain and sensitivity may be so reduced that you can not copy the weak, desired station.

The amateur bands may appear to

be full of weak commercial stations *which are really operating outside the* bands — heterodynes, birdies and broadcast stations appear. Strong ssb stations produce less obvious effects which make the bands seem noisy and full of splatter. All these conditions are produced by deficiencies *within* the receiver.

There are a number of ways in which strong, undesired signals outside the i-f passband can interfere with reception. Some require only a single undesired signal to be present; others require two or more signals. Single signal effects include adjacent channel interference, image interference, i-f breakthrough, strong-signal spurious responses, desensitization and blocking. Multiple signal effects include cross-modulation and rf intermodulation.

single-signal interference

Adjacent-channel interference is caused by a strong, undesired signal close to, but outside of, the receiver's i-f passband. This is the fault of the main selectivity determining filter. The filter either has a poor shape factor or the ultimate attenuation (stop band) is not deep enough. Some filters, for instance, have skirts that go down to only 50 or 60 dB before they flatten out. One solution to this problem is cascading two or more filters. Care in matching filter center frequencies and proper isolation produce ultimate attenuations of 120 dB or more and shape factors approaching 1:1.

Image frequency interference is a function of rf selectivity and the frequency of the first i-f. Secondary images between the first and second i-f stages of multiple-conversion receivers are also possible. Many current receivers have image rejection ratios as low as 50 dB on at least one band. However, with an i-f in the megahertz range, image ratios of 100 dB or more are possible if economy is not an overriding factor. Up-conversion to an i-f above the receiver tuning range in conjunction with a front-end low-pass filter is also very effective.

I-f breakthrough occurs when a signal on the frequency of the i-f rides through *the front-end and into the i-f by brute* force. The i-f rejection ratio of a receiver is a function of its rf selectivity, and runs in the range of 50 to 70 dB for amateur receivers and up to 70 to 100 dB for professional and military receivers.

The problem is much more severe with *variable* first i-f receivers than with *fixed* first i-f receivers because it is difficult to find a 500- to 1000-kHz slice of the spectrum with no strong stations, and further, because simple traps can reduce i-f breakthrough in fixed i-f receivers where band elimination filters are required for variable i-f receivers. Up-conversion with a low-pass filter is one of the most effective solutions to the i-f breakthrough problem.

Strong-signal spurious responses are produced in two ways. First, strong signals can ride through the front end and mix with harmonics of the first oscillator to produce the i-f. Second, a nonlinear rf amplifier or mixer can generate harmonics of a strong signal which beat with the local oscillator. Rf selectivity and filtering of the injection frequencies are the cure for this problem.

The best receivers have strong-signal spurious responses of 100 dB in relation to a 1-μV desired signal. That is, it takes a 100-mV undesired strong signal to produce a receiver output equivalent to the output produced by a 1-μV desired signal. A 0.3 mV signal (50 dB relative to 1 μV) can produce strong signal spurious responses in less expensive receivers.

Desensitization and blocking are different degrees of severity of the same problem. In desensitization a strong signal outside the passband reduces the gain of the receiver which may make it impossible to hear a weak desired signal. In blocking, the gain is reduced to such an extent that the receiver goes silent. Both desensitization and blocking are caused by a signal which rides through and is rectified by the first active device causing a shift in the operating point of the device. If the first device is also connected to the agc system, the rectified voltage can be fed back through the agc line to affect other stages as well. These problems are most common in the immediate vicinity of transmitters.

Professional class receivers specify desensitization and blocking in terms of the unwanted signal level required to cause a 3-dB drop in receiver output when tuned to a 1 mV desired signal. 100 mV is a typical desensitization specification for such a receiver. These characteristics are seldom specified on lower priced receivers but tests have shown that some will completely block at 35 mV or less.

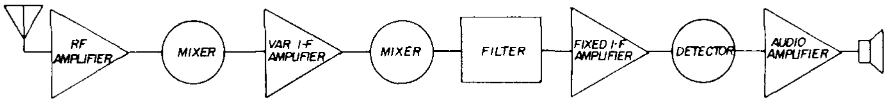


fig. 1. Signal path through a typical modern communications receiver.

cross-modulation

Cross-modulation is a mixing effect that is produced when a desired signal and a strong, undesired signal are applied simultaneously to a device with third-order curvature of its input-vs-output transfer characteristic. The first and second mixers are the stages most likely to produce cross-modulation but very strong signals can also produce it in the rf amplifier. The result of cross-mod is that the modulation of the undesired signal is superimposed on the desired signal and cannot be removed by subsequent processing. Cross-mod is aggravated in the first stage of a receiver by the popular gain control methods which change the operating conditions of the device (see **fig. 5**). Any attenuation ahead of the offending stage is beneficial even if the desired signal is also attenuated, because 1 dB of attenuation reduces cross-modulation by 2 dB. Of course, attenuation of the undesired signal by rf selectivity without affecting the desired signal is preferred, but this is not always possible if the undesired signal is close to the passband.

Cross-modulation is seldom specified except in professional receivers and even there a lack of standard conditions and levels makes direct comparisons impossible. The undesired signal required to produce a certain level of cross-mod is specified, but the reference cross-mod level is variously given as −10 dB, −20 dB or −30 dB relative to the desired signal output, as 3% cross-mod, or as "negligible". More important, the spacing of the undesired signal from the desired signal may be anywhere from 10 to 100 kHz or may be expressed as a percentage up to 10%. Cross-mod performance is improved by use of greater rf selectivity and more linear active devices. A given active device can often be made more linear by optimizing its operating conditions.

intermodulation

Rf intermodulation (IM) is, like cross-modulation, the result of third-order curvature of a device. If there are two strong undesired signals, f_1 and f_2, they will produce two third-order products, one at $f_1+(f_1-f_2)$ and the other at $f_2-(f_1-f_2)$. Fifth-order curvature can also produce much weaker IM products spaced $2(f_1-f_2)$ from the two offending signals. As an example, two strong signals, one at 3450 kHz and the other at 3490 kHz, can produce two IM products in the 80-meter band, a third-order product at 3530 kHz and a fifth order product at 3570 kHz. Two other IM products fall outside the amateur band at 3410 and 3370 kHz. Perhaps this is why the 80 meter band on

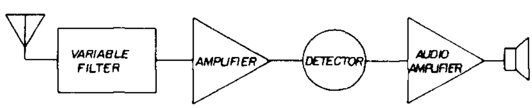


fig. 2. Ideal receiver signal path for handling strong signals.

your receiver sounds full of RTTY and other commercial stations.

There are two ways in which IM is specified in professional receivers. One is to tell how far the IM product is below the level of the two signals which cause it. Third-order IM, for example, can be specified as, "at least 60 dB below two 10-mV undesired signals." IM can also be specified as the undesired signal level to produce an IM product equivalent to a 1-μV desired signal. The better professional and military receivers require from +70 dB to +100 dB relative to 1 μV to produce third-order IM equivalent to a 1-μV desired signal. Improvement in IM performance is accomplished by the same means as for cross-modulation.

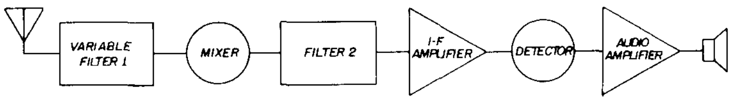


fig. 3. Compromise receiver signal path for handling strong signals.

receiver signal path

The typical modern communications receiver (**fig. 1**) has a signal path which is not ideal from the strong-signal standpoint. The problem with this design is that four stages are exposed to strong undesired signals before the passband-determining filter can reduce them to harmless proportions.

The ideal receiver configuration for handling strong signals (**fig. 2**) is a throwback to some of the TRF receivers of the 1920s which had all their tuned circuits lumped between the antenna and the first rf stage. The filter in the ideal receiver, however, must be adequate to provide adjacent channel selectivity to modern standards – a shape factor of 2:1, 2.5 kHz bandwidth, ultimate rejection greater than 100 dB, insertion loss 1 or 2 dB. Such a filter would stop the strong undesired signals before they got into the receiver, unlike the two or three tuned circuits in most receivers which allow signals 50 or 100 kHz off frequency to ride through with little attenuation. High-frequency crystal-lattice filters which meet these requirements for single frequencies are available, and receivers such as this, covering one or several fixed frequencies, are in use.

A practical, tunable receiver which can approach the ideal in performance is shown in **fig. 3**. The objective is to provide maximum adjacent-channel selectivity as close as possible to the antenna. The mixer must be low noise and as linear as possible; FL1 should consist of two to four tuned circuits, depending upon the noise figure of the mixer and the target noise figure for the entire receiver. The i-f must be high enough so FL1 can adequately suppress images and low enough

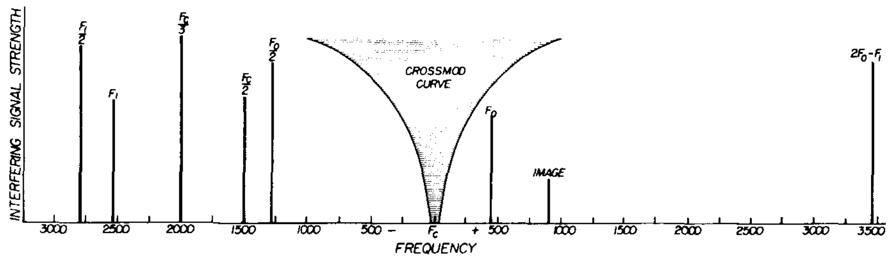


fig. 4. Plot of strong-signal responses in a typical communications receiver. Frequency f_c is the center frequency to which the receiver is tuned (3000 kHz), f_o is the oscillator frequency (3455 kHz), and f_i is the intermediate frequency (455 kHz).

to be practical, say, in the range of 1.5 to 50 MHz.

Higher intermediate frequencies remove the i-f from the receiver tuning range and permit the use of up-conversion in conjunction with a low-pass filter ahead of FL1. The disadvantage of the higher frequencies is that filters, while available, may be expensive and difficult

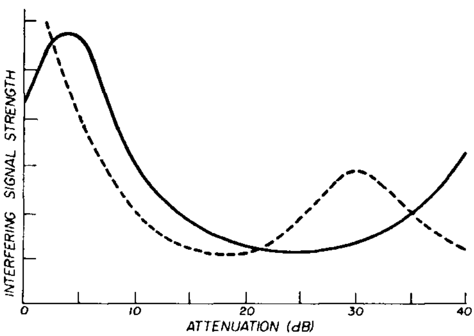


fig. 5. Interfering signal level required to produce 1% cross-modulation in two different active devices.

to locate. The stability and constant tuning rate usually associated with the variable first i-f, multiple-conversion receiver can be achieved with this configuration by deriving the injection frequency for the first mixer through the pre-mixer technique. In this case, complexity has been removed from the signal path and added to the frequency determining circuits where it can do no harm to the signal.

receiver design trends

The receiver design trends of the last twenty years have, almost without exception, been in the direction of poorer strong-signal performance. One of the innovations of that period is all solid-state receiver design. In general, semi-conductors do not handle strong signals as well as vacuum tubes, and the use of semi-conductors in stages ahead of the adjacent-channel selectivity filters degrades strong-signal performance.

Multiple conversion, another design innovation, results in two mixers and three to five total stages before there is appreciable selectivity to protect the amplifiers and mixers from strong undesired signals. Broadband and variable i-f stages are susceptible to i-f breakthrough.

Furthermore, the newer low-noise devices, both tubes and semi-conductors, tend to be less linear than the older vacuum tubes. The low-impedance (50-ohm), tightly-coupled primaries on modern antenna coils compound the strong signal problem because they degrade the Q of the tuned circuit. They also present higher signal levels to the active device than did the old medium-impedance (200- to 500-ohm) primaries.

evaluating strong-signal performance

The best method of evaluating the strong signal performance of the receiver is that used for military and professional receivers. Two signal generators are used to plot cross-mod and spurious responses as shown in **fig. 4**. In plotting the cross-mod curve one generator feeds in a desired signal (10 to 100 μV) at the frequency to which the receiver is tuned; the second generator is swept out from the desired signal frequency, first in one direction and then the other, representing a strong undesired signal. The amplitude of the undesired signal necessary to produce the reference cross-mod level is recorded at enough points to produce the curve shown in **fig. 4**.

The first generator is removed from the circuit and the second generator is swept through the spectrum again. Any

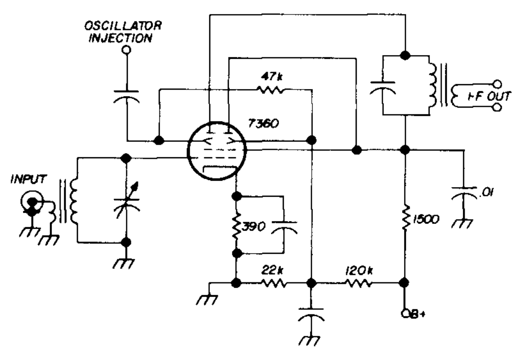


fig. 6. Unbalanced 7360 beam-deflection mixer circuit.

discrete responses such as image and i-f breakthrough are recorded. The undesired signal strength required to produce a response equivalent to a 1-μV desired signal is recorded for the discrete responses.

Since there are an infinite number of signal combinations which can produce IM, you must be content with spot checks in evaluating this characteristic. Set one generator at f_c plus 30 kHz and the other at f_c plus 60 kHz. The amplitude of both generators must be the same. Increase the amplitude of the two generators until a response appears at f_c equivalent to that produced by a 1-μV desired signal. The level of either generator is then the IM response level and may be expressed in dB relative to 1 μV.

There are only two ways to improve the ability of a receiver to handle strong signals: Reduce the strength of the undesired signals or, in the case of cross-mod and IM, improve the linearity of mixer and amplifier devices in the stages ahead of the adjacent-channel selectivity filter.

Reducing the strength of the undesired signals is the method used in the receiver configuration in **fig. 2.** If the undesired signals can't get into the receiver, they can't do any damage. In most receivers you have to get along with something less than ideal rf selectivity, but strive for the maximum practical selectivity. Reducing the undesired signal by 1 dB will reduce cross-mod by 2 dB and IM by 3 dB, so even a small amount of additional selectivity can make a decided improvement.

If ideal rf selectivity isn't available then the linearity of the amplifier and

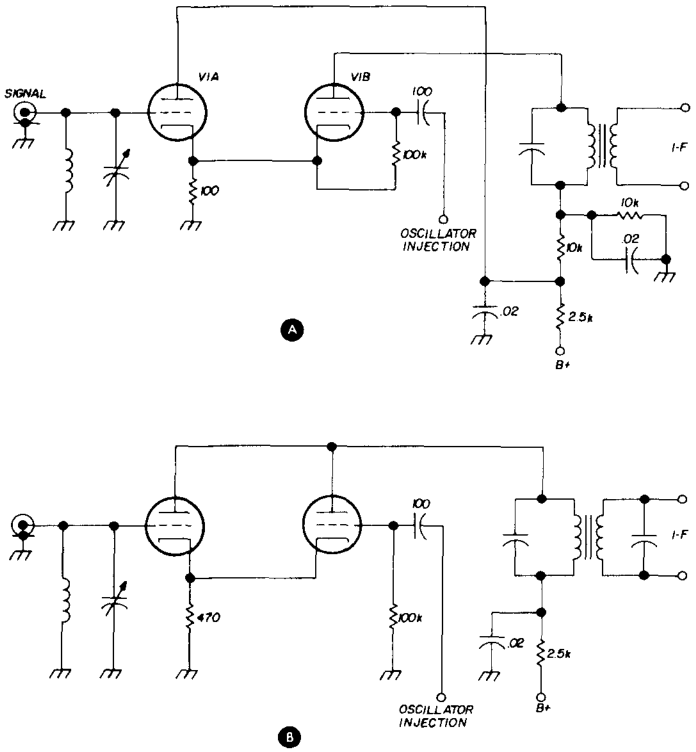


fig. 7. Two dual-triode mixer circuits. The circuit in (B) is not as sensitive as the circuit in (A), but (B) will handle larger signals. These circuits are suitable for vacuum tubes such as the 12AU7, 12AT7 or 6DJ8.

mixer devices becomes important. Not only should the most linear devices and circuits be selected, they must be optimized for strong-signal performance. Each active device has an optimum point at which it is least susceptible to crossmod and IM. This is illustrated in **fig. 5**

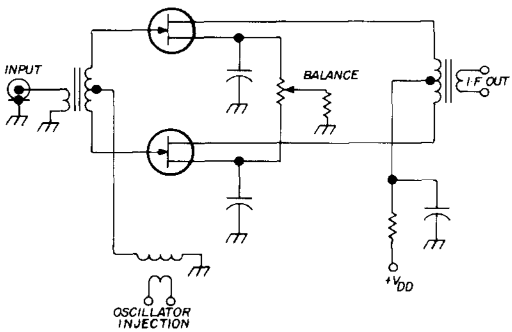


fig. 8. Balanced mixer circuit using a field-effect transistor.

which shows generalized cross-mod-vs-attenuation curves typical of active devices when attenuation is produced by changes in bias.

Most amateur receivers suppress all strong-signal effects from out-of-passband signals by a minimum of 50 dB. The suppression of military and professional receivers runs from 70 to 100 dB or more. The noise figure of amateur receivers runs from 5 to 8 dB, that of professional receivers is usually around 10 dB. The cost of amateur receivers is $250 to $800, professional receivers $5000 to $10,000 and up. Obviously, sensitivity is cheap while strong-signal performance is expensive.

It can not be stated too often that good strong-signal performance in modern receivers is the result of painstaking design work. It is not enough to pick out a signal path configuration and the circuit for each stage. Each stage must be experimentally optimized for operating point, voltages and injection levels. If there are two or more circuits under consideration for a given stage, each must be optimized, and then compared.

strong-signal performance

The following paragraphs detail the steps which are necessary in the design of a receiver with superior strong-signal performance.

First of all, determine the maximum acceptable noise figure. Many professional receivers are designed for a noise figure of 10 to 12 dB. If the input device of the receiver has a noise figure of 6 dB the designer then has an excess of 4 to 6 dB to use in providing additional rf selectivity, to keep the gain low ahead of the adjacent channel selectivity filter, and to allow optimum strong-signal biasing of stages.

For amateur work where it is possible to take advantage of the rare occasion when a 5- or 6-dB noise figure is usable the best idea is to have an auxiliary low-noise preselector that can be switched in ahead of the receiver. It is easy to add a preselector to a receiver that has sacrificed noise figure for superb strong-signal characteristics, but it is difficult to improve the strong-signal characteristics of a receiver that has been designed for low noise.

Next, select the signal-path configuration. For general use the arrangement of **fig. 3** is recommended. A low-gain rf amplifier can be added if the mixer does not have the required sensitivity. Note that it is *not* necessary to go to the variable first i-f approach to achieve the vfo type tuning we expect in modern receivers.

mixers

The mixer stage is the key to the design of a superior strong-signal receiver. If the configuration of **fig. 3** is to be used to its fullest, the mixer must provide low noise, high conversion transconductance and exceptional linearity. Fortunately, there are devices and circuits which possess these characteristics to a much greater degree than the mixers found in the average medium-priced receiver.

The problem with many mixers is that the device is biased to an operating point where it is not linear so that the required second-order (sum and difference) frequencies are generated. However, at that point the device is also likely to be an efficient generator of third- and higher-order products which cause cross-modulation and rf intermodulation. Following are some recommended mixers which have been used in professional or military receivers or which are of unusual interest.

Squires developed a mixer circuit with the 7360 beam deflection tube in 1963 which has been used in a number of amateur receivers and at least one commercial receiver.[1] An unbalanced version of the circuit is shown in **fig. 6**. The tube is set up for linear operation between G1 and the plates; the signal is switched between the active plate and the grounded plate by the oscillator voltage appled to deflection plate.

Another source indicates that superior performance is obtained from the circuit with a fixed bias (about 1.9 V) and with an oscillator injection of 7.5 volts.[2] Squires' original balanced circuit had a noise figure of 5.5 dB at 29 MHz and handled undesired signals up to 1.5 volts.

Various dual-triode mixer circuits perform well because they are low noise and require little or no gain ahead of them. The 12AU7, 12AT7 and 6DJ8 are some of the tubes which have been used. In the circuit of **fig. 7A** V1B is a triode mixer with the signal injected at the cathode and the oscillator at the grid. V1A is a cathode follower which provides isolation between the signal and oscillator circuits. The 10k resistors in the plate circuit of V1B form a voltage divider to reduce the plate voltage because V1B must have a much lower transconductance than V1A. A somewhat different circuit is shown in **fig. 7B**. Sensitivity of this circuit is not as good as that of **fig. 7A** but it will handle larger signals.

The fet balanced mixer (**fig. 8**) is a good choice for use in the circuit of **fig. 3**. When used with suitable devices (such

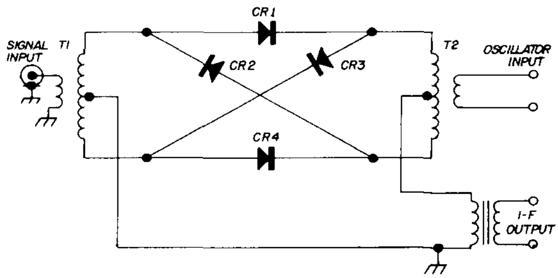


fig. 9. Diode balanced mixer has approximately 8-dB noise figure and handles large signals well. Diodes CR1-CR4 are hot-carrier diodes; transformers T1 and T2 are toroidal types.

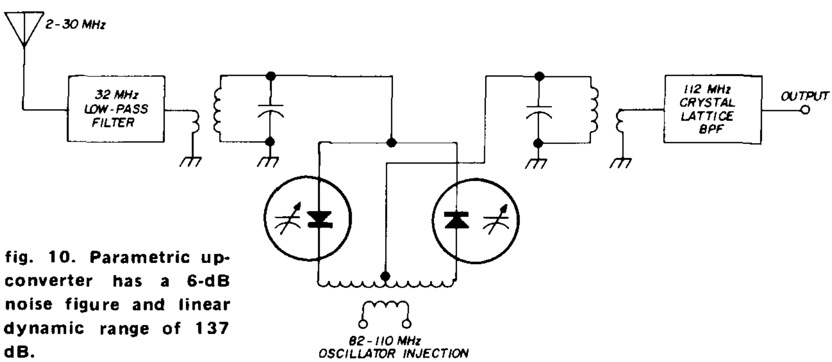


fig. 10. Parametric up-converter has a 6-dB noise figure and linear dynamic range of 137 dB.

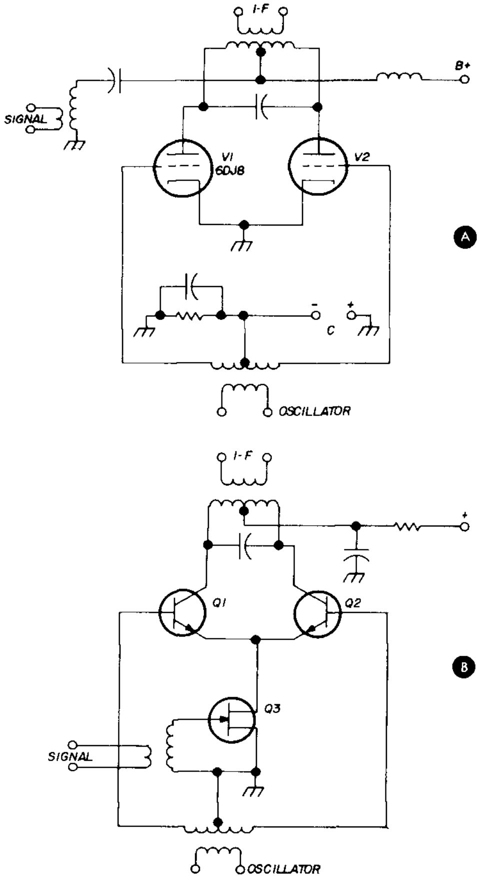


fig. 11. Vacuum-tube (A) and transistor-type (B) switching mixer circuits.

as the 2N4416) it has a noise figure of 4 to 5 dB and handles large signals fairly well. The noise figure is low enough to allow a rather elaborate rf filter to be placed between it and the antenna.

The diode balanced mixer using hot-carrier diodes in **fig. 9** has a noise figure around 8 dB and handles strong signals well. However, it requires high local-oscillator power level and has conversion loss, so it must be preceded by an rf amplifier in order to achieve an acceptable overall noise figure. These are both disadvantages.

A parametric up-converter **(fig. 10)** is used in the National R1490/GRR17 wide dynamic range military receiver.[3,4] The specified linearity of the circuit is 137 dB and the noise figure is 6 dB. All external spurious responses, images, i-f breakthrough, cross-mod, IM, etc., are down more than 100 dB. The 112-MHz filter sharply attenuates all undesired signals more than a few kHz outside the i-f passband. Adjacent-channel selectivity is provided in a later stage at 5 MHz.

Up-conversion is advantageous because a simple low-pass filter can be used to increase the rejection of the i-f and image frequencies without the added complexity or loss that additional tuned circuits would bring. The up-conversion technique can be used with any of the other mixer circuits as well.

The 7360 mixer operates as a very linear switching circuit. Attempts have been made to improve the technique and to develop semiconductor equivalents. Perhaps the ultimate performance so far was also by Squires with a dual-triode switching mixer **(fig. 11A)** in a receiver that handled 3-volt rms signals within 10 kHz of the desired signal, and 25-volt signals 10% removed, without cross-mod.

He used a 6DJ8 tube and the oscillator injection had a square-wave characteristic. The tube was biased as a class-C amplifier and the oscillator had sufficient amplitude to drive the grids positive. The signal was alternately switched to ground through the two tubes by the oscillator injection voltage. A stage of rf amplification was used ahead of the mixer which worked into a 6-kHz wide filter. A somewhat similar scheme using semiconductors **(fig. 11B)** has been tried, but details on its performance are not available.[5] The signal is amplified in Q3 and alternately switched to ground through Q1 and Q2 and the output transformer.

rf amplifiers

If an rf amplifier must be used, the rule is to use only enough gain to override the mixer noise, using any excess gain to provide additional rf selectivity either by adding tuned circuits or tapping down on the existing tuned circuits to improve Q. In general, the best rf amplifier devices are vacuum-tube pentodes or triodes in the cascode circuit. Next in order are fets, and last are bipolar transistors. When receivers *must* be all solid-state, circuit designers have gone to power fets and power bipolars for rf amplifiers in order to improve strong signal performance.[3,6]

Rf amplifiers must be adjusted experimentally to determine the best bias, plate, screen, drain or collector voltages. If the gain is higher than required it should not be reduced by changing the operating conditions, but by adding rf selectivity through additional tuned circuits, looser coupling or tapping down.

gain control

The method by which the front-end gain is controlled is important to strong-signal performance. As shown in **fig. 5**, if a conventional gain control method is used which changes the operating point of the device, it results in serious degradation in the ability of the device to handle strong signals. The preferred method of manual gain control is a resistive attenuator ahead of the first active device (**fig. 12**).

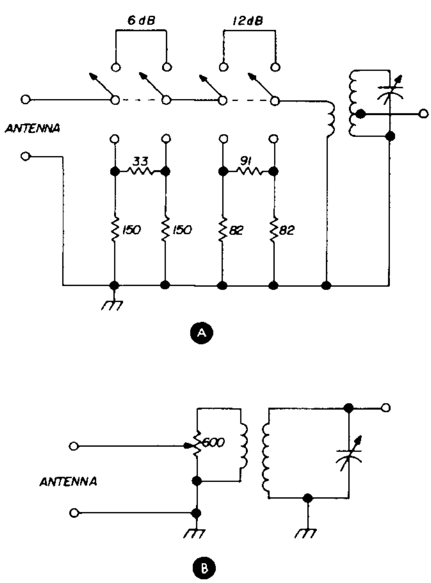


fig. 12. Two types of attenuators which may be used to control signal input to communications receivers. Step attenuator is shown in (A); simple potentiometer attenuator is shown in (B).

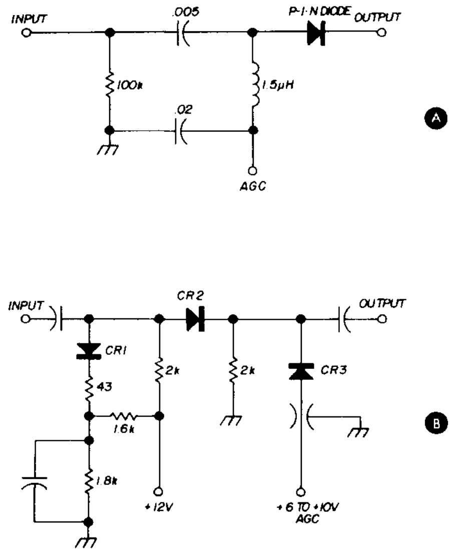


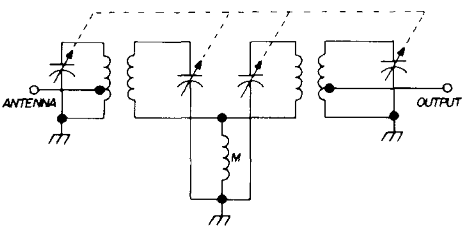
fig. 13. Agc voltage-controlled attenuator circuits using PIN diodes. In the circuit in (B), with +6 volts on the agc line, minimum attenuation is 1 to 2 dB (CR1 and CR3 off, CR2 on). With +10 volts on the agc line, miximum attenuation is 38 dB (CR1 and CR3 on, CR2 off).

voltage-controlled attenuator using PIN diodes ahead of the first stage. A single diode attenuator is shown in **fig. 13A** and a more complex three-diode version with both forward and reverse biased diodes is shown in **fig. 13B**.[7,8] The designer must be alert to the possibility that the cross-modulation level of the diodes can be less than that of the amplifier or mixer device that they are intended to protect.

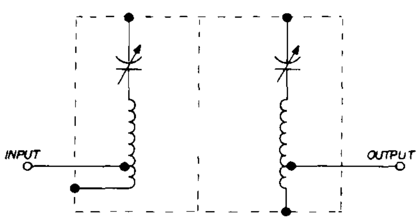
selectivity

Rf selectivity is important in the search for the ultimate in strong-signal capability since a perfect rf filter will eliminate all forms of strong signal interference. Crystal-lattice filters are available throughout the high-frequency range and are the near perfect answer for fixed frequency operation.[9,10] Unfortunately, if you are interested in more than a few fixed channels you must go on to less perfect filters.

Helical resonators are perhaps the next best rf filters (**fig. 14B**). They are not easily adaptable to continuous tuning and they become quite bulky in the high-frequency range, but they can give Qs of 1000 or more which results in bandwidths of 1 kHz per MHz; 14 kHz at 14 MHz for example.[10,11,12,13]



A



B

fig. 14. Four-circuit rf filter (A), and helical resonator (B).

Cascaded tuned circuits are also effective and most modern receivers have at least two such circuits between the antenna and first stage, and some have as many as four. One arrangement is shown in **fig. 14A**.

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integrated-circuit speech clipper

Rf clipping with the LM-373 i-f strip IC provides low distortion and superior bandpass shaping

Charles G. Bird, K6HTM, 875 Lindo Lane, Chico, California 95926

Almost all types of speech processors, and their vices and virtues, have been discussed in these pages. The "audio-rf-audio" low-level processor, as represented by the Comdel CSP-11, has yet to be examined in detail. The method used in the Comdel unit provides speech clipping and filtering analogous to that of rf clippers, but the processed waveform is supplied to the ssb exciter input stage at audio level. A significant increase in average-to-peak talk power is claimed.[1]

operating principles

A block diagram of the Comdel unit appears in **fig. 1.** A closed-loop system is used, with output at the original audio frequency. Instantaneous amplitude limiting occurs, but does not introduce any harmonic components.[1]

The microphone input signal is amplified and mixed with a local-oscillator signal, which is common to the balanced modulator and product detector. Two filter stages are used, which must be capable of passing a signal for ssb service. The filtered signal is clipped, passed through another (identical) filter and applied to a product detector. The resulting audio signal, which is further processed by a low-pass filter, may be applied to an ssb exciter input stage.

The unit to be described consists basically of two ICs, a fet local oscillator, a balanced modulator, and two mechanical filters.*

*A possible source for the filters is Star-Tronics, Box 17121, Portland, Oregon 97217. The MFC-8040 and LM-373 are available from Circuit Specialists, Box 3047, Scottsdale, Arizona 85257. Helpful information on the MFC-8040 and LM-373 will be found in the bibliography at the end of the article. **editor.**

In **fig. 2** a Motorola MFC-8040 is used as a low-noise audio stage, followed by a diode ring modulator and an usb 500-kHz Collins mechanical filter (BW = 2.75 kHz), which drives the agc stage of a National Semiconductor Products LM-373. Output from this stage at pin 9 is clipped and filtered by a second filter and reinserted at pin 4 of the LM-373. causes the MFC-8040 to overload on loud speech. The input to this stage is therefore shunted with a level pot. A subminiature Allen-Bradley unit is available in a blister pack, which can be easily mounted on the circuit board.

The modulator and clipper diodes were on hand and were carefully matched for low forward resistance. There may be

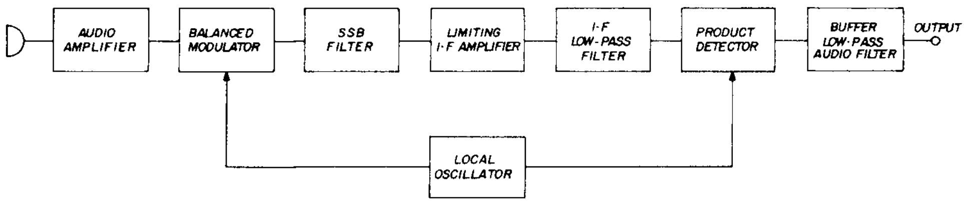


fig. 1. Block diagram of the Comdel CSP-11.

Local-oscillator output at 500 kHz is coupled to the balanced modulator and also to pin 6 of the LM-373; audio is derived from pin 7.

The beauty of the LM-373 is that its upper frequency limit is 15 MHz, thereby permitting the use of any popular filter, whether home-made with low-frequency surplus crystals or with readily available 9-MHz units.

circuit description

The schematic of the IC processor is shown in **fig. 3**. A microphone such as the Turner 454-C has excessive drive, which

an advantage to using hot-carrier diodes in the clipper circuit.[2]

No special attention was paid to obtaining carrier suppression other than observing physical symmetry in layout of modulator components, since the carrier is common to both modulator and detector. If it's desired to use the unit as an exciter base by providing the processed signal after the second filter to an external connector, then greater precision in balancing would be required. Capacitor C1 was found to be about 15 pF. The rf output may be monitored at J1 with an oscilloscope or low-frequency receiver.

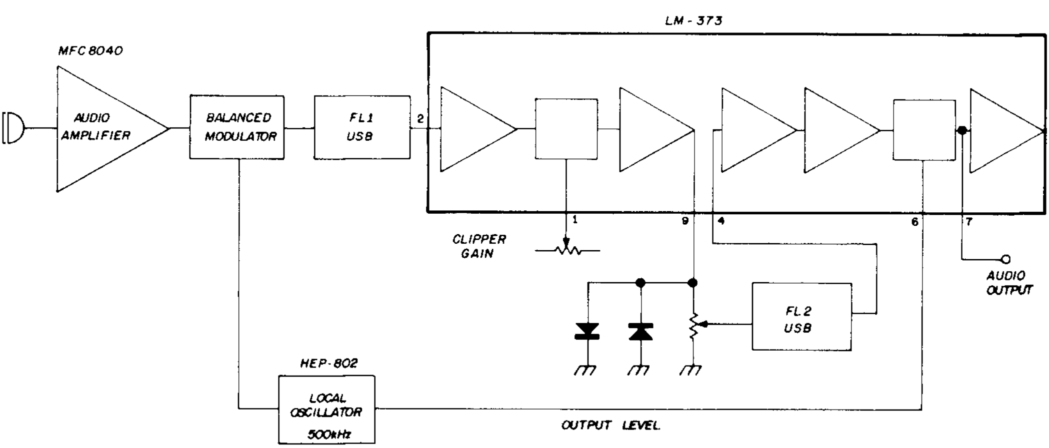
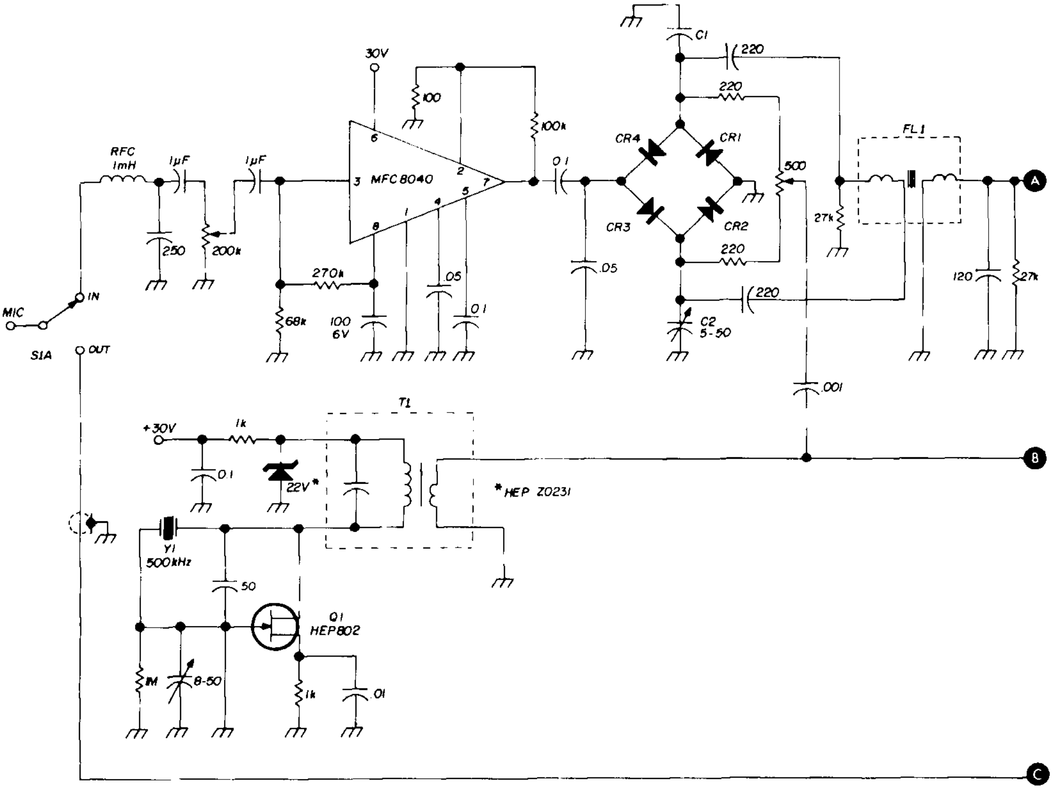


fig. 2. Block diagram of author's speech clipper using two ICs.



C1	value chosen to balance with C2
CR1-CR4	1N75 matched for low forward resistance
CR5,CR6	1N75, matched for low forward resistance, or hot-carrier diodes
FL1,FL2	Collins F500Z-12-6618 mechanical filter, 2.75 kHz passband
T1	455-kHz i-f transformer (Miller 88101). See text
Y1	500 kHz. Channel 70 FT-241 holder, marked 27.0 MHz (JAN Crystals)

fig. 3. IC speech clipper schematic.

The output-level control should be fully open for best indication of carrier balance.

carrier oscillator

The 500-kHz oscillator uses a 455-kHz subminiature i-f transformer with the slug approximately half way out of the coil form. Oscillation will cease at a point in this direction, so adjustment is fairly critical. About 9 volts of rf can be measured on the primary and about 0.5 volt on the secondary. A 22-volt zener is used to regulate the voltage and protect the HEP-802.

power supply

The point at which the clipper gain control is set is quite dependent on the voltage applied to the LM-373. The load on a 12-volt battery, for example, will

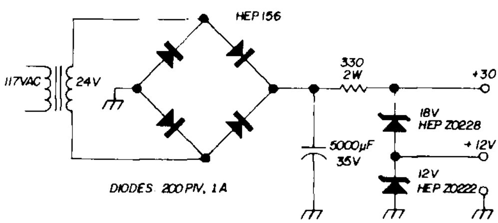
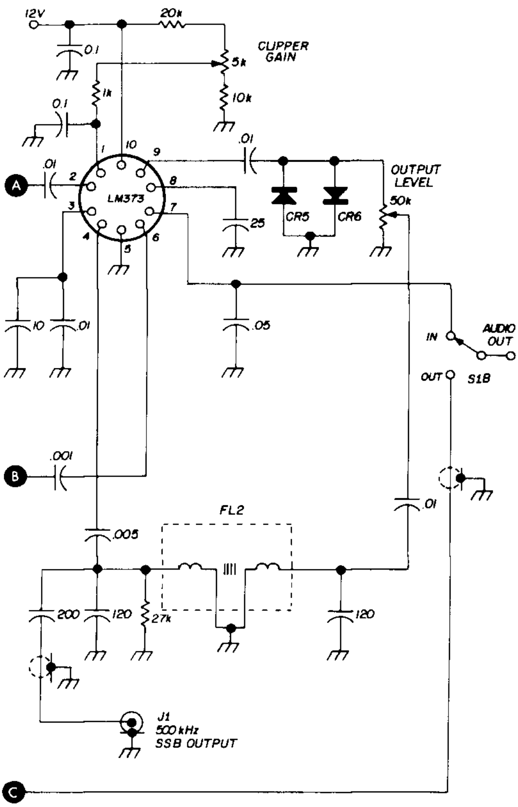


fig. 4. Power supply for the speech clipper.



shift the clipping point counter clockwise because of voltage drop. By the same token, a 30-volt battery used for the MFC-8040 and Q1 will be quickly depleted. A suitable power supply is shown in **fig. 4.**

adjustments

Preliminary adjustments are made to ensure that Q1 oscillates. (This circuit and helpful hints are given by Hank Olson, W6GXN. See reference 3.)

With the output connected to an audio amplifier, the operation of the LM-373 should be checked by listening for ambient noise. If voltage is applied to the MFC-8040 but no speech is heard, you can at least be assured that the LM-373 is working if the transient generated by the make and break voltage to the MFC-8040 is heard through the remainder of the unit. The problem can be isolated at the MFC-8040 or before. An audio oscillator is useful here. Rf filtering at the processor input is necessary.

The unit described is mounted on a 2-1/2 x 4-1/4-inch pc board and placed inside a 3 x 5 x 7-inch chassis turned on its side, with a hand-fashioned one-piece cowl placed over the sides and top. It is painted to match Drake styling.

conclusion

Performance was all that was hoped for, but as expected, not much better than that of a typical agc-type compressor in terms of additional sock to the signal. Direct comparisons were made with the speech processor described by K6PHT.[4] Scope displays were perhaps slightly fuller with the IC clipper described here. On-the-air reports seemed to favor the clipper for over-all quality, but did not necessarily indicate its superiority in increased average-to-peak signal strength.

It appears that low-level rf clipping is beneficial mainly with regard to low distortion and superior bandpass shaping. Another possible advantage over the agc-type compressor appears to be greater dynamic range; that is, a lower threshold of background noise for the same amount of increased average-to-peak power. Judicious adjustment of the clipper gain and output-level controls bears out this contention.

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vhf receiver scanner

Automatic channel monitor using TTL logic

Bob Reifsteck, K2LZG, 81 Bonita Drive, Rochester, New York 14616

The purpose of a scanner is to allow several vhf receiving channels to be monitored automatically, thus eliminating manual switching between channels. In operation, a slow-running oscillator is turned on and off by the receiver squelch circuit. Flip-flops, controlled by the slow-running oscillator, alternately turn one receiver oscillator on and off, and the process repeats at the next receiver oscillator. When the scanned channel is active, the receiver squelch circuit stops the slow-running oscillator, which conditions the flip-flop so that the station can be monitored.

This article describes a scanner using TTL logic. Some of its features are summarized below.

1. Either positive or negative logic can be used for squelch control.
2. Oscillator switching and channel indication can be accomplished in several different ways.
3. Etched circuit board or breadboard layout can be used.
4. As many as 20 channels can be switched with the addition of compatible devices.

design considerations

It was desired to produce a versatile, inexpensive, simple, and reliable unit. TTL logic provides easy interface with a wide variety of receivers, is reliable, and has recently enjoyed price reductions.

operation

Three two-input NAND gates are used as an oscillator whose frequency is determined by a 1k resistor and 300 μF capacitor (**fig. 1**). The fourth NAND gate connects the oscillator to a counter (four internally connected flip-flops). When the oscillator gate is off (LO input), the counter remains at its last count. When the oscillator gate is on (HI input), the counter proceeds with an upward consecutive count to eight. The counter is reset automatically by a jumper from pin 11 to pins 2 and 3 and begins counting again from zero. This action continues until the squelch circuit gates the oscillator off. As the scanner counts, it sequentially turns on one receiver oscillator at a time by

from being fed back to the scanner. It may also be desirable to bypass the scanner output for rf with a 0.001-μF capacitor on each output.

Note that the scanner is connected for receiving only. If the scanner is installed

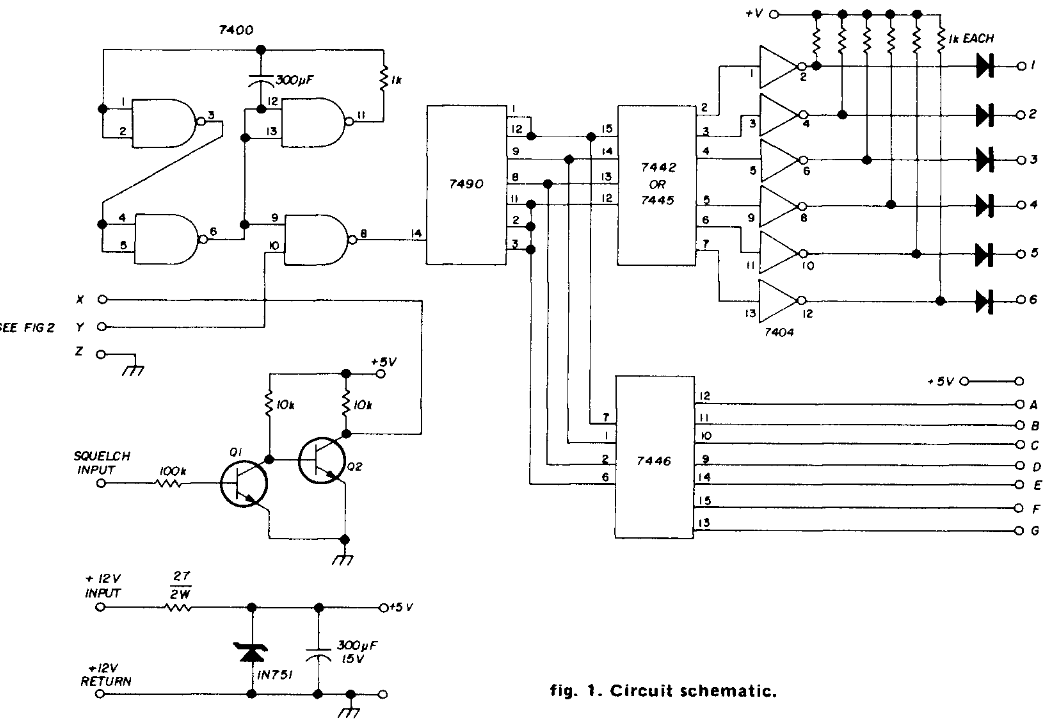

fig. 1. Circuit schematic.

either forward biasing a diode connected to a crystal, or by applying bias directly to the oscillator circuit. Either a seven-segment readout or individually marked lamps can be used as indicators to identify the channel being monitored. The seven-segment readout is driven by a special decoder-driver IC, which receives its input from the counter BCD output and translates the count to indicate the channel. Lamps may be driven directly from the decimal decoder. The oscillators can be driven from the decimal decoder directly or by an inverter following the decoder. depending on the voltage sense required to switch your receiver oscillator circuit. It is recommended that series diodes be used at the scanner output to the oscillators to prevent receiver voltages

in a transceiver that uses a common switch to change both receive and transmit channels, ensure that the transmit crystal does not become enabled by the scanner, or you may transmit on several

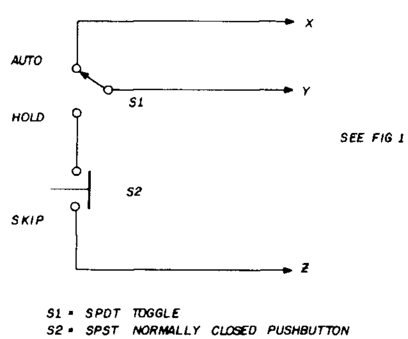

fig. 2. Suggested circuit for manual override control.

channels at the scan rate. It's best to choose a switch position for receive without crystals in either the receive or transmit socket. Use this switch position to enable the scanner. When in radio contact, switch the channel selector to

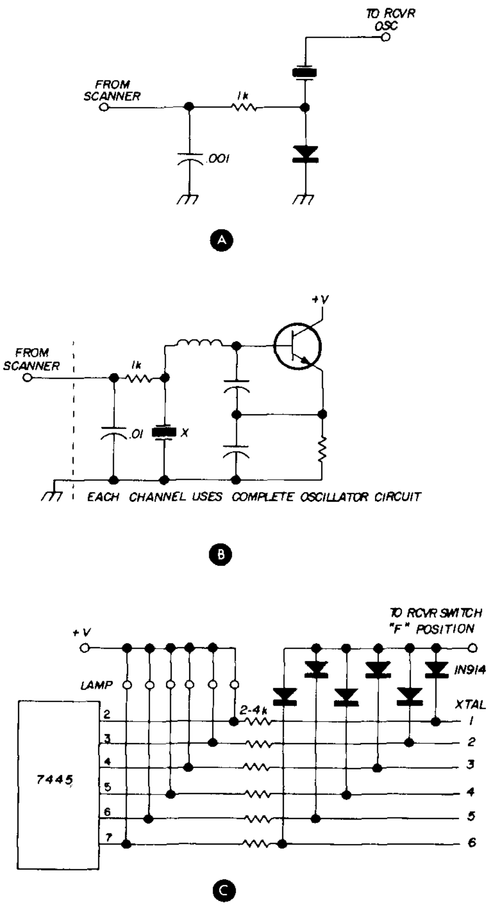

fig. 3. Receiver oscillator control circuits. Method A switches crystal directly; method B switches bias to oscillator. Circuit in C is for oscillator control in Regency receivers.

the appropriate position and disable the scanner; that is, don't put the scanner in hold and attempt to transmit!

inputs

power supply. The unit requires +12 V at 220 mA if you use the zener circuit.

squelch. Provision is made to accept either:

A. A +5-volt signal to enable scan and a zero-volt signal or ground to stop scan.

B. A +5-volt signal to stop scan and a zero-volt signal or ground to enable scan.

The choice of A or B depends on the voltage available from your receiver squelch circuit. For situation A, use the complete input circuit with two transistors **(fig. 1)**. For situation B, use only one transistor and be sure to use a high-value base resistor (100k or more) to prevent loading your receiver squelch circuit.

The scanner will work without the switches, but for convenience and flexibility, switches are recommended. This is especially true if one of the monitored channels is a repeater. A toggle switch can be used to change from auto to hold, and a momentary pushbutton switch can be used to skip from one channel to another. See **fig. 2.**

outputs

channel indication. If you are using a seven-segment readout, wire the unit as indicated for that section. If you are using indicator lights, one end of each lamp can be tied together and connected to a positive voltage, depending on the lamps used. The other end of each lamp can then be connected to the appropriate 7445 or 7442 terminal. The 7445 can handle up to 30 volts and sink as much as 80 mA, although low-current, low-voltage lamps are preferred.

control of oscillators

This scanner can switch oscillators and indicate channels in several different ways. The standard version, shown in **fig. 1**, is used with a seven-segment readout and controls an oscillator similar to that indicated in **figs. 3A** and **B** by applying forward bias to a diode or by biasing the oscillator directly. If more than 4.5 volts are needed to operate an oscillator, use an open collector inverter (7406) instead of the "totem pole" output inverter (7404). The 7404 should not be operated above 5 volts. The 7406 can be operated with 30 volts on the open output (although package V_{CC} must remain at +5 volts). If you use lamp indicators, you can connect them to each 7442 output, provided the lamps require 5 volts or less.

special case -- the Regency receiver

Some receiver oscillators don't lend

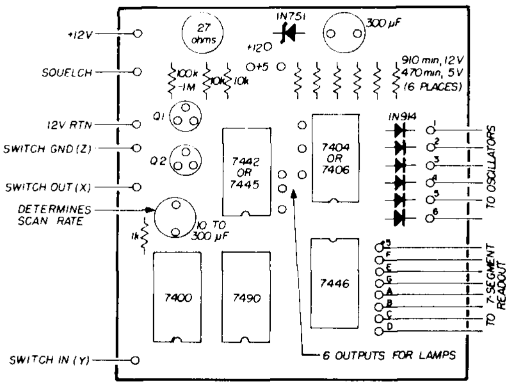

fig. 4. Component layout. Indicators can be numbered lamps or 7-segment readout devices.

themselves to an easy switching method, such as described above. **Fig. 3C** is an example of a scheme for switching oscillators in the Regency receiver. The diodes are at +8 volts and rf ground. Each diode cathode is connected to an oscillator crystal. The common side of the lamp is tied to +12 volts. When the 7445 ouptut is off, 12 volts appear across the lamp and resistor. This causes the diode to be reverse biased, keeping the crystal above rf ground. When the 7445 ouptut goes LO (ground) the lamp turns on, current flows from the +8-volt source through the diode and resistor to ground, which causes the diode to be forward biased. This action provides an rf path for the crystal to turn on.

Referring to the layout diagram, **fig. 4,** the following procedures also apply if the scanner is to be used with the Regency.

Insert diodes in place of the pull-up resistors. Insert resistors (2 to 4k; value determined by trial) in the 7404 socket between pins 1&2, 3&4, 5&6, 8&9, 10&11, and 12&13. (Do not use the 7404.) If you wish to use a digital readout, replace the lamps with 1k resistors and connect the common side to +12 volts.

construction

Assembly is straightforward. If an etched circuit board is used, follow the parts layout diagram, **fig. 4.** If you're breadboarding, any logical layout will work. Note proper device orientation: diode cathodes have a band: IC dot locates pin one. Inputs and outputs are labeled on the drawing. A parts list appears in **table 1.***

table 1. Parts list.

item	description	quantity
SN7400	gate	1
SN7490	counter	1
SN7442	decoder	1
SN7446	decoder	1
SN7404	inverter	1
2N4140	NPN transistor	2
1N914	diode	6
1N751A	zener	1
300 µF	capacitor	2
27 ohm 2W	resistor	1
100k	resistor	1
10k	resistor	2
1k	resistor	7
7 segment readout		1
readout socket		1
board		1

summary

These examples indicate the versatility possible with the scanner. You can supply it with either positive or negative logic for squelch control. You can control either positive or negative logic oscillators. Higher voltage loads can be switched using the open-collector gates. A choice of lamps or seven-segment readout is available. Adding another inverter from the decoder and removing the counter reset allows ten oscillators to be controlled. By adding one flip-flop and another decoder, as many as twenty oscillators can be controlled.

ham radio

*This scanner is available in kit form from Hamtronics in Rochester, New York. For information, send a self-addressed, stamped envelope to Jerry Vogt, WA2GCF, Hamtronics, Inc., 182 Belmont Road, Rochester, New York 14612.

how to use
Plessey SL600-series
integrated circuits in amateur communications equipment

A complete description of the versatile Plessey SL600 linear ICs, and how to use them in receivers and transmitters

James M. Bryant, G8FNT, Plessey Linear Applications Engineer

The Plessey SL600 series of integrated circuits for use in transmitters, receivers and other communications systems is now in use all over the world, and Plessey continually receives inquiries from radio amateurs who want applications data on the different SL600 circuits. In the hope of satisfying this need, G8FNT, a linear applications engineer for Plessey, has prepared this article.

The Plessey SL600* series of ICs includes rf and i-f amplifiers with low cross-modulation and good agc; audio amplifiers with and without agc, high-performance balanced modulators and speech agc generators. Also included in the series is a complex circuit containing a-m and ssb detectors, and a CW-operated agc system.

This article describes some transmitters and receivers that are based on the use of SL600 ICs, but does not cover the audio sections or high-power rf amplifiers. The first part of the article describes a variety of communications systems which use Plessey ICs. The latter part of the article gives circuit details and comments on some potential causes of trouble experimenters might run into.

*The complete line of Plessey SL600 ICs is available from Circuit Specialists, Box 3047, Scottsdale, Arizona 85257. Write to them for their complete price list, or see their advertisement in this issue.

receiver systems

The simplest receiver which can be built from SL600 ICs is the direct-conversion unit shown in block form in **fig. 1.** This direct-conversion receiver, also known as a synchrodyne, can be used for the reception of a-m, ssb and CW. The vfo is tuned to the carrier frequency in the case of a-m and ssb, and a few hundred hertz away for CW. Upper and lower sidebands are equally well detected by this receiver, and if the audio passband is limited, it is quite selective.

However, if this simple direct-conversion receiver is used to receive an upper-sideband ssb signal adjacent to another ssb signal only 2 or 3 kHz away, the interference will be quite severe. This interference can be removed, and only one sideband detected, with the more complex phasing system shown in **fig. 2.**

The direct-conversion receiver in **fig. 2** uses rf and audio phasing to cancel one sideband, so it is truly a single-sideband receiver. In this circuit it is necessary to have accurate phasing of the signals, and well matched gain in the two audio channels feeding the summing stage. The upper or lower sideband may be selected by reversing the audio phasing. (The rf phase may also be reversed for the same purpose, but switching the audio is easier.) The system in **fig. 2** detects the S-meter. Depending upon the sensitivity required and the audio gain available, one or two rf amplifiers may be used. The SL610 IC has a gain of 20 dB, and frequency response to at least 146 MHz. (This performance, which exceeds that shown on the SL610 data sheet, depends on very careful layout, very short leads and very great attention to coupling and

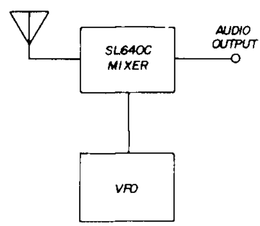

fig. 1. Block diagram of the most simple direct-conversion receiver which can be built with Plessey SL600 ICs.

decoupling of power supplies and agc. However, amateurs who use the SL610 on two meters find that the performance at these frequencies is satisfactory.)

Other ICs which may be used for the rf amplifiers are the SL611 and SL612. The SL611 provides 26 dB gain and is usable to 80 MHz; the SL612 has 34 dB gain with frequency response to 15 MHz. The amplifier you choose, here and in the other systems to be described, depends upon the frequency and the gain re-

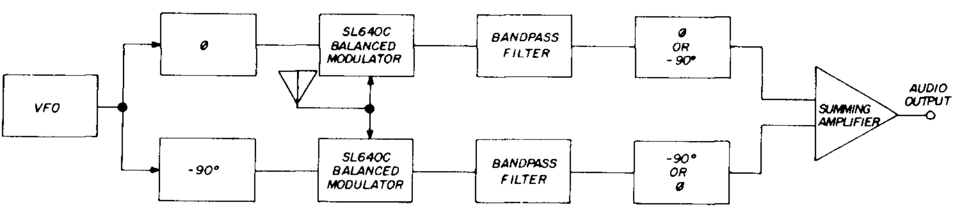

fig. 2. Block diagram of a phasing-type direct-conversion ssb receiver.

lower side-band when the upper channel phase shift is positive.

Another direct-conversion receiver is shown in **fig. 3.** Whereas the circuit of **fig. 1** is subject to interference, is not very sensitive and has no agc, the circuit of **fig. 3** has rf filters to minimize cross-modulation, an rf amplifier, agc and perhaps, an quired. The SL612 has the extra advantage of lower current consumption and slightly lower noise figure.

conventional superhet

A much more conventional superhet receiver is shown in **fig. 4.** This design consists of an rf stage with agc (which would probably be an SL610 IC), a mixer (SL640 or SL641), an i-f filter (LC, crystal or ceramic), an i-f amplifier with agc and a detector.

The i-f amplifier could be one or two stages, depending on the sensitivity required, but agc would normally be applied to only one stage. An SL640 or SL641 would be suitable for the ssb and CW detector, followed by an SL621 to provide audio agc. If a-m operation is required, an SL623 could be used. This IC also generates carrier agc, and when used with a bfo, detects CW or ssb.

For fm detection either the SL432 or SAA570 may be used, but a separate carrier detector is required to provide automatic gain control.

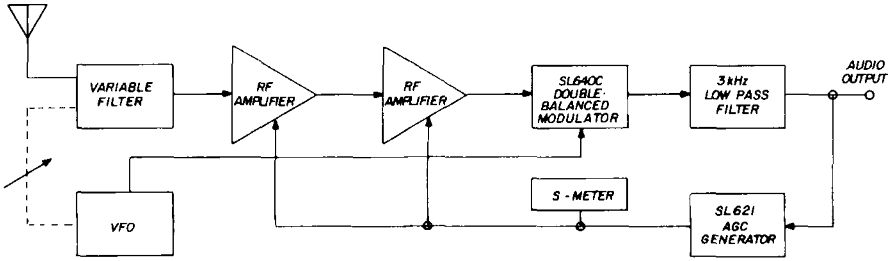

fig. 3. Practical direct conversion receiver can be used successfully on the amateur high-frequency bands.

agc output of SL623 and the audio-derived agc provided by an SL621 connected to the ssb output of the SL623.

The i-f filter may also be switched, with a narrow bandwidth filter for ssb, and a wider one for a-m. To detect narrowband fm, a detector such as the SL432 or SAA570 is connected to the output of the second SL612C. During narrowband fm reception agc is taken from the SL623.

Double-conversion superhets may also be designed using SL600-series ICs, but with modern filters, double-conversion superhets are rarely needed on the amateur high-frequency bands. However, they are occasionally used on uhf or where complex tuning systems are required.

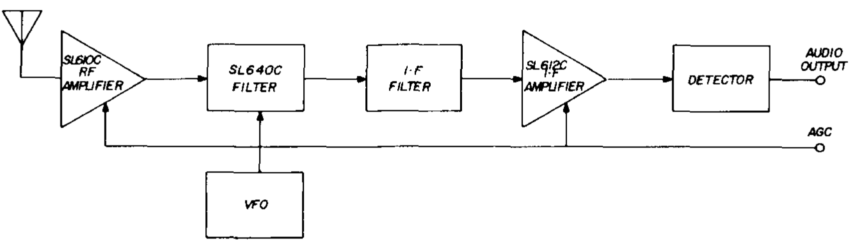

fig. 4. Layout of the basic superhet receiver.

A more complete superhet circuit which features front-end tuning and both a-m and ssb detection is shown in **fig. 5.** The output of the audio stage is switched between the two detector outputs of the SL623 IC. The agc line, which also drives an S-meter, is switched between the CW Inasmuch as the same techniques are used as in the single-conversion superhets shown in **fig. 4** and **fig. 5,** no double-conversion designs will be described here. However, it should be noted that SL600 devices have high gains, and you should avoid using too many amplifying stages.

ssb exciters

A basic filter-type ssb exciter is shown in **fig. 6.** The audio and a low-frequency rf signal from an oscillator (the bfo if the exciter is part of a transceiver) are mixed in an SL640 IC. The SL640, as a result of its good carrier rejection, provides a clean dsb suppressed-carrier signal at the output. This dsb signal is passed through a narrow bandpass filter to remove one sideband. The remaining sideband is converted to the final operating frequency by another SL640. The image is removed by a filter, and the output is connected to a linear amplifier.

A more complete filter type ssb exciter with automatic level control (alc) is shown in **fig. 7.** In this circuit the SL610C amplifier is controlled by an alc signal which, in most cases, is derived from the final amplifier stage, either by a threshold detection system or by grid-current detection in the output tube.

A phasing-type ssb exciter is shown in **fig. 8.** The audio speech signal, which must normally have limited bandwidth, is phase shifted so that two separate, equal-amplitude audio signals with a 90° phase difference are obtained. These audio signals are applied to the signal inputs of two SL640 ICs, rf reference and quadrature signals are applied to the carrier inputs, and the two output signals are summed.

If the audio and rf reference signals are applied to one modulator, and the quadrature audio and rf signals are applied to the other, the lower-sideband outputs will be in phase and will add. The upper-sideband outputs will cancel, providing a lower-sideband output. Similarly, if the audio reference and carrier quadrature signals are applied to one modulator, and the audio quadrature and carrier reference are applied to the other, upper-sideband output is obtained.

This method of generating ssb appears attractive in many respects, and has the advantage that no expensive filters are required. Also, the carrier frequency may be varied so no further frequency conversion is necessary. Unfortunately, the

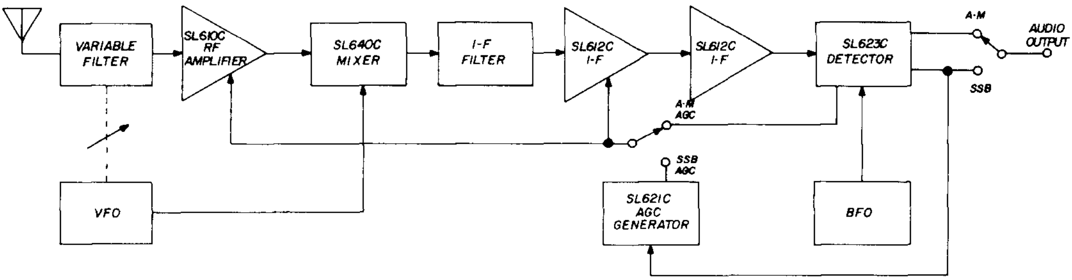

fig. 5. Complete superhet communications receiver for ssb, a-m and CW. Fm detection can also be added as described in the text.

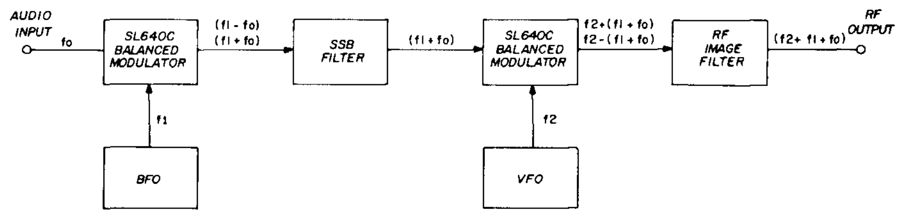

fig. 6. Basic filter-type ssb exciter.

phasing systems has one serious drawback: To keep the undesired sideband 40 dB below the desired sideband, the phasing, both audio and rf, must be accurate within 2°. Also, the amplitude of the rf carrier applied to one modulator must be adjusted to minimize second sideband generation, and carrier leak must be minimized in both modulators.

However, despite the adjustment problems, this method of obtaining a ssb signal is very popular, probably because no expensive filters are required. The system shown here is compatible with the direct-conversion receiver in **fig. 2**, and a very simple ssb transceiver can be built by combining these two systems.

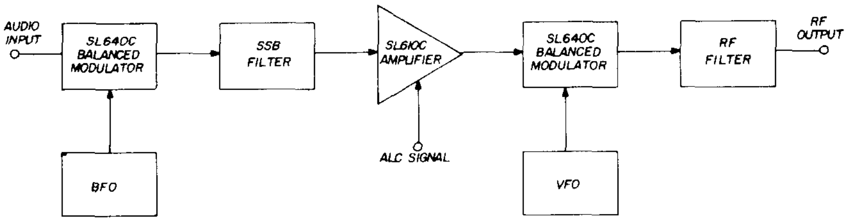

fig. 7. Ssb transmitter with automatic level control (alc).

amplitude modulation

Since a-m is merely double sideband with carrier, an SL640 may be used as an amplitude modulator if carrier leak is increased. If a 15k resistor is connected between pin 2 of an SL640 and ground as shown in **fig. 9**, there will be sufficient carrier on the output of the SL640 for a-m. By switching the resistor in and out of the circuit either a-m or dsb may be produced. If you also switch the filters following the SL640, a-m, dsb or ssb may be obtained from the same SL640 with the same inputs. With this simple arrangement you can build a multi-mode transmitter with very few components.

transceivers

If you look over the illustrations in **figs. 5** and **7** or **figs. 2** and **8**, you'll note that ssb transmitters and receivers of the same types are quite similar. Therefore, with a little signal switching, it is possible to make one set of SL600 ICs perform as both a transmitter and a receiver. This, of course, saves both on SL600 ICs and expensive filters. **Fig. 10** shows the block diagram of a typical ssb transceiver based on the use of SL600-series ICs.

rf clipping

As has been noted by a number of designers, audio limiting and audio clipping are not useful techniques for increasing the average-to-peak power ratio of ssb transmitters, although audio agc is (derived, perhaps, from an SL622 vogad* circuit). If clipping is used, it must be performed on the rf ssb signal and the clipped signal must be filtered to remove splatter.

The rf clipping system shown in **fig. 11** needs careful initial adjustment but yields remarkably good results. The input audio, which should be agc controlled, is con-

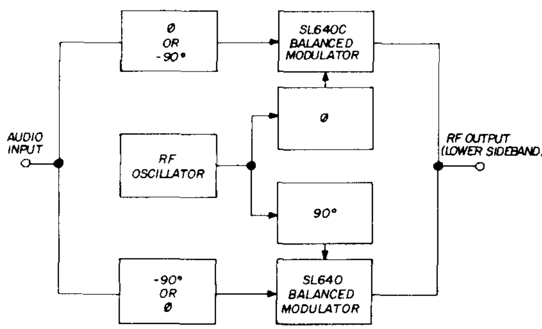

fig. 8. Phasing-type ssb exciter.

*Vogad is an acronym for voice-operated gain-adjusting device.

verted to ssb in the basic system; then the ssb signal is clipped by a symmetrical peak clipper. The signal is then refiltered to remove splatter and is passed through an alc amplifier and converted to the final operation frequency. The audio input level must be adjusted so that clipping is not so excessive that it destroys intelligibility.

If the clipper is replaced by a Schmitt trigger, and the audio input is given 12 dB per octave pre-emphasis above 1 kHz, a class-C power amplifier may be used. The output signal is received as ssb, although it has slight distortion. This arrangement provides a peak power equal to mean power during speech. If carrier leak is allowed to occur during pauses in speech so that the transmitter is always delivering the same power to the antenna, tvi is much reduced. In this case alc — and hence the SL610C — is not needed.

other systems

The Plessey SL600 integrated circuits may also be used in various other parts of amateur communications equipment. **Fig. 12** shows a mixer vfo which mixes the output of a low-frequency vfo with a crystal-controlled signal to produce a stable high-frequency vfo. With this circuit in a multiband receiver, several crystals may be used to tune several different bands with one vfo.

An IC agc system which is designed to stabilize the amplitude of an rf carrier is shown in **fig. 13.** A simple low-power IC linear amplifier is shown in **fig. 14.** In this circuit the value of the emitter resistor

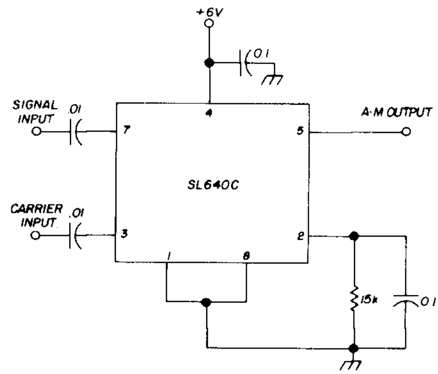

fig. 9. Amplitude modulator using a Plessey SL640 IC.

depends upon the power transistor used in the output stage.

If audio squelch is required in a receiver, the system shown in **fig. 15** will provide it. This circuit is based on the fact that if pin 7 of an SL630 audio amplifier is grounded, the circuit is muted. The circuit illustrated, when turn-

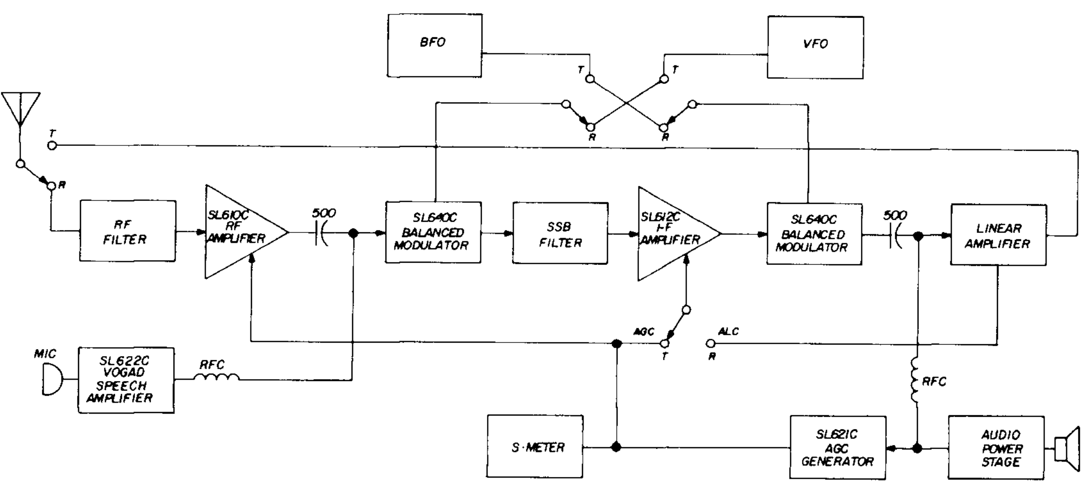

fig. 10. Complete ssb transceiver based on the use of Plessey SL600 ICs. During transmit the SL610C, SL621C and audio output stage are turned off; during receive the linear amplifier and SL622 are turned off.

ed on, insures that the SL630 is muted until the agc reaches a preset level. This prevents unwanted receiver noise when no signal is being received. The agc signal may be derived from an SL621, SL623 or other sources. Any high-beta silicon NPN transistors are suitable for this circuit — a Plessey SL301C monolithic dual transistor is shown here.

A VOX system may be easily added to any transceiver which uses the SL622 as a microphone amplifier. A possible circuit is shown in **fig. 16.** It consists of an op-amp which is switched by the agc voltage of the SL622, and in turn switches the transmit-receive relay in the transceiver. The transistor may be any high-gain silicon type which can carry the relay current. However, a Darlington arrangement must be used to make sure the relay turns off again. This is because the minimum output of the op-amp can sometimes be more than 0.7-volt above the negative supply line; this is sufficient to turn on a single transistor.

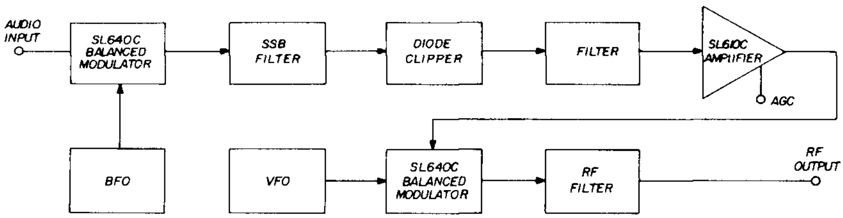

fig. 11. Ssb transmitter with rf clipping.

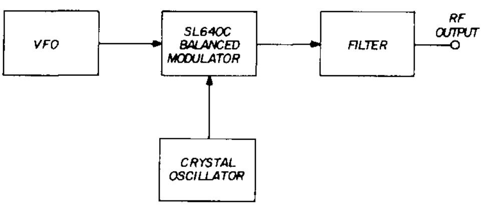

fig. 12. Basic circuit for the mixer-vfo.

communications receiver

The communications receiver circuit shown in **fig. 17** is the same circuit shown in block form in **fig. 5.** Perhaps the easiest way of explaining the use of the SL600 family of ICs is to describe this circuit and its operation in detail.

Starting from the antenna, the input filter depends upon the i-f and the band being tuned. It must be sufficiently narrow to provide rejection at the image frequency (that frequency on the other side of the local oscillator from the wanted frequency and spaced the same amount from the oscillator frequency). If the image frequency gets through the input and mixes with the local oscillator it will produce an unwanted i-f signal.

The SL610 rf amplifier is coupled to the input filter in such a way that the IC is never inductively terminated. This is because the SL610 can become unstable if it looks into an inductance. The input coupling is also chosen so that the input filter Q is not lowered.

If an SL610 input is connected to a source which might be inductive, the source should either be shunted with a few thousand ohms, or a few hundred ohms should be connected in series with the input to the IC. The SL610 is biased by connecting the bias pin (pin 6) direct-

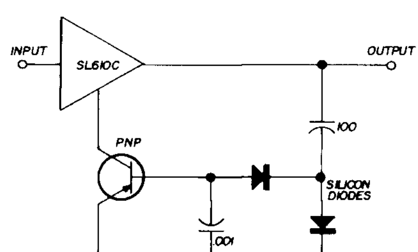

fig. 13. Carrier agc system uses one IC.

ly to the input (pin 5). (This same biasing arrangement is used with all the other rf and i-f amplifiers in this receiver.)

If an SL610, SL611 or SL612 are connected as shown in **fig. 18**, slightly

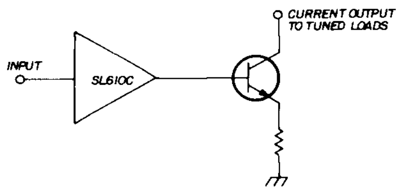

fig. 14. Low-power linear amplifier stage.

lower noise will result, but this is not usually worth the extra complexity. It is important that the input and output grounds on these devices be kept separate – output currents flowing through the input ground leads tend to produce instability.

Both the agc line and the SL610 positive supply (which is shared with the SL640 mixer) are decoupled to ground. Ideally, this is not necessary, but rf on power supply and agc lines can cause trouble with some circuit layouts. Where expense does not rule out decoupling, it is recommended. (The SL640 supply is not internally decoupled although that of the SL610 is.) To minimize the output current loop of the SL610 the SL640 ground (pin 8) should be as near as possible to the output ground of the SL610 (pin 8).

The output of the SL640C first mixer drives the input of the crystal filter. The

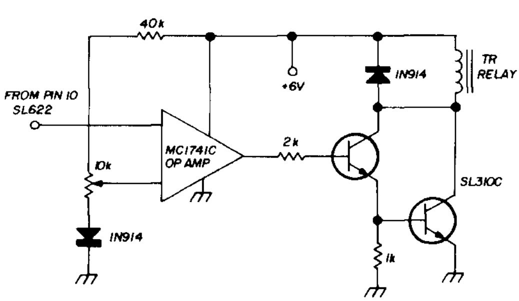

fig. 16. Simple VOX circuit for use with SL622C.

filter must be terminated by the correct impedance (pure resistance or resistance shunted by capacitance). If the resistive component is low enough, an SL641 may be used in the mixer circuit as shown in **fig. 19.** This is the case where SL640s are used: They may be replaced by SL641s in certain circumstances.

When the output from the SL640 is taken at pin 6, it requires an external load greater than 560 ohms. This is because the pin-6 output is a low-impedance emitter follower and it must not be used to drive capacitive loads. Some filters have transformer-type inputs with low dc resistance to ground (less than 10 ohms). In this case the terminating resistor, as long as it is larger than 560 ohms, may also be used as the load resistor. In this

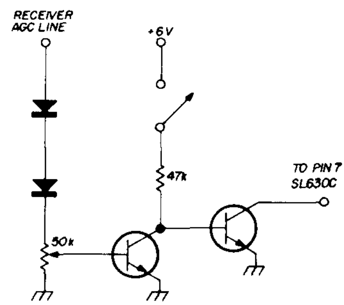

fig. 15. Audio squelch system.

case the dc blocking capacitor must *not* be used.

Pin 2 of the SL640 and SL641 must be decoupled to ground through a low-leakage capacitor (less than 0.1 μA). The reactance of this capacitor must be less than 10 ohms at the lowest input or carrier frequency. The carrier input from the local oscillator should be 100 to 200 mV rms and should be as free from modulation as possible.

The broadband i-f amplifier following the crystal filter consists of two SL612 ICs; agc is applied to only one stage at pin 7. The SL612 has a 70-dB agc range, while the agc range of the SL610C rf amplifier is 50 dB, giving a total for two gain-controlled stages of 120 dB. If both SL612 i-f amplifiers were agc controlled, the total would be 190 dB, which is too much.

The positive power supply to the i-f stages and the SL640 detector is decoupled, and care must be taken to make sure that ground currents at the output of the i-f strip cannot flow near its input as this would lead to instability. The best grounding arrangement for the i-f strip is shown in **fig. 20.** No other connections should be made to the i-f strip ground.

The crystal filter must be properly terminated at its output. The input of an SL612 IC is approximately 5k in parallel with 4 pF. If necessary, this should be shunted (at ac only) by other resistors and capacitors to provide the correct filter-terminating impedance.

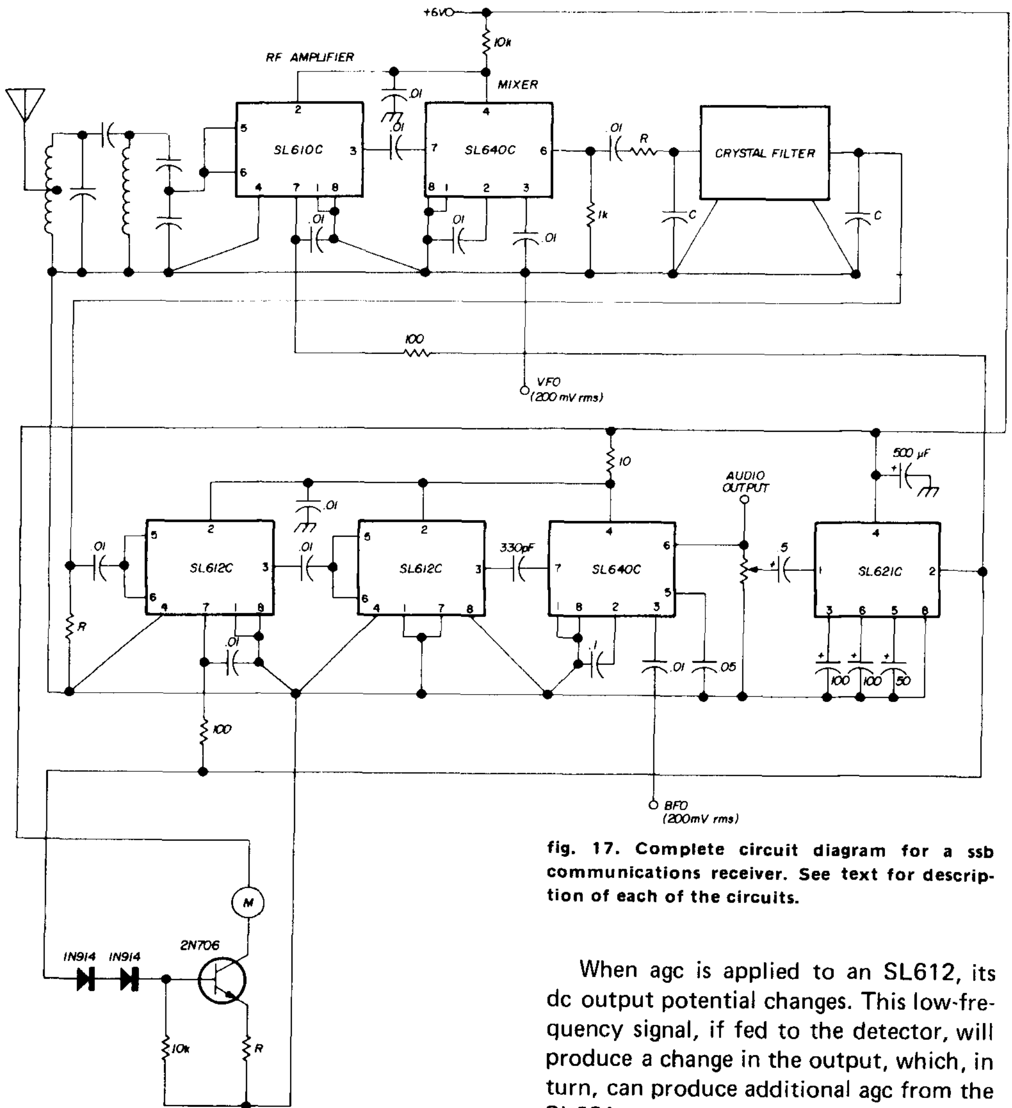

fig. 17. Complete circuit diagram for a ssb communications receiver. See text for description of each of the circuits.

When agc is applied to an SL612, its dc output potential changes. This low-frequency signal, if fed to the detector, will produce a change in the output, which, in turn, can produce additional agc from the SL621 agc generator which can cause very low-frequency stability or motorboating. To prevent this, the coupling capacitor between the last SL612 i-f stage and the SL640 detector should be as small as possible – about 330 pF is usual if the i-f is over 1 MHz. Another solution to this problem is to place a tuned circuit at this point; this prevents the trouble and also reduces noise produced in the broadband i-f stages.

The output of the SL640 detector is decoupled to ground at frequencies above 4000 Hz with the 0.05 μF capacitor from pin 5 to ground. The load across pin 6 is a 1000-ohm preset potentiometer. The audio output to the amplifier is taken directly from pin 6, but the audio for the SL621 agc stage is taken from the potentiometer wiper. With this arrangement the agc threshold can be adjusted so that noise in the antenna and receiver circuits does not turn on the agc in the absence of a signal. The coupling capacitor to the SL621 should not exceed 1 μF or low-frequency instability may result.

The SL621 agc generator will usually drive a 500-μA S-meter connected in series with 5100 ohms and three silicon diodes from the agc output to ground. Occasionally, however, this is too much load for an SL621, and the transistor S-meter circuit shown in **fig. 18** is preferable. The value of the emitter resistor depends upon the meter used, and is given by the following formula:

$$R = \frac{2.7}{I}$$

where I is the full-scale current in mA and R is in kilohms. For a 1-mA meter, this works out to be 2700 ohms. With this circuit the S-meter reads linearly in dB; from zero to full scale is about 120 dB.

The power supply to the SL621 must be well decoupled; 500 μF from pin 4 to ground is usually sufficient, but if the audio output stage shares the same power supply, this value should be increased. If a series-stabilized power supply is used, it should have a source impedance of less than 1 ohm.

The audio output stage may be an SL630, SL402, SL403 or other suitable audio power amplifier.

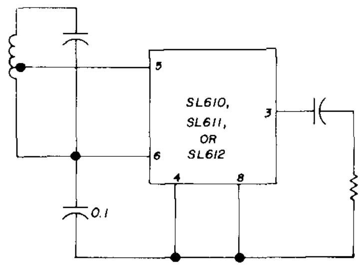

fig. 18. Low-noise signal coupling to the SL610 SL611 or SL612.

other applications

When SL600-series ICs are used in a transmitter or a transceiver they are used in much the same way as described above. However, since transmitters often contain rather large rf fields, particular attention must be paid to shielding and decoupling. In some cases it may be necessary to decouple individual stages.

When mixing frequencies or generating ssb in a transmitter, the original input frequencies are not wanted in the output. The SL640 and SL641 have approximately 30 dB signal and carrier rejection, but this may be increased with the circuit shown in **fig. 21**. With signal, but no rf carrier, R1 is adjusted for minimum carrier leak. All modulators used in transmitters may be adjusted in this way

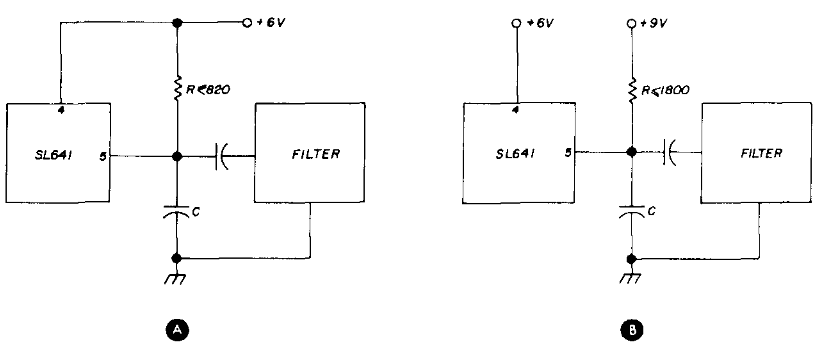

fig. 19. Circuits for matching the SL641 IC to filters.

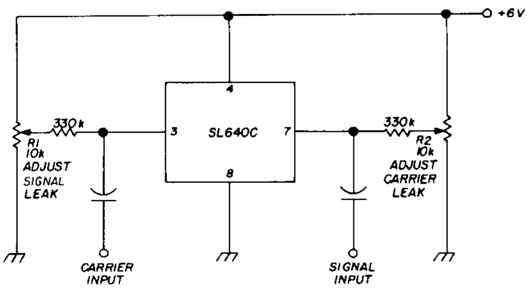

fig. 21. Signal and carrier-leak adjustment for the balanced modulator.

although it is less important in filter-type systems than in phasing systems.

The agc characteristics of the SL610, SL611 and SL612 are temperature dependent. It is unwise to use a voltage on an agc pin to set the gain of a stage. However, this may be done where agc is applied to another stage in the chain to compensate for signal variations.

The SL610, SL611 and SL612 tend to oscillate if they are required to drive a capacitive load. Such loads should be buffered by a resistance or another type of amplifier. For the SL610 and SL611 a 47-ohm buffer resistor should be used; a 150-ohm buffer resistor is used with the SL612. When an rf signal is taken from any of these SL600 amplifiers to points far removed, care must be taken to prevent instability caused by ground loops.

using the SL623

The SL623 IC combines the functions of a low-level, low-distortion a-m detector and agc generator with a ssb demodulator. It was designed specifically for use in ssb/a-m receivers, and is not used in ssb-only receivers. A typical application for the SL623 is illustrated in **fig. 22.** Since the agc output from this circuit is CW derived, if audio-derived agc is required for ssb operation, an SL621 should be used. In the circuit of **fig. 22** the resistor between pins 2 and 5 sets the value of carrier at which agc operation begins. The bfo signal should be a clean sine wave at about 100 mV rms.

When using the SL623 all the decoupling capacitors should go to one point. Also, the positive power supply should be decoupled. The SL623 is as sensitive to ssb as the SL640, but it requires 125 mV rms of a-m to activate the agc. Therefore, greater i-f gain may be necessary. Despite statements to the contrary in the data sheet, the SL623 functions to at least 30 MHz and, with reduced performance, to over 120 MHz.

other devices

The other members of the SL600 family are the SL620, SL622 and SL630. The SL630 is an audio amplifier with

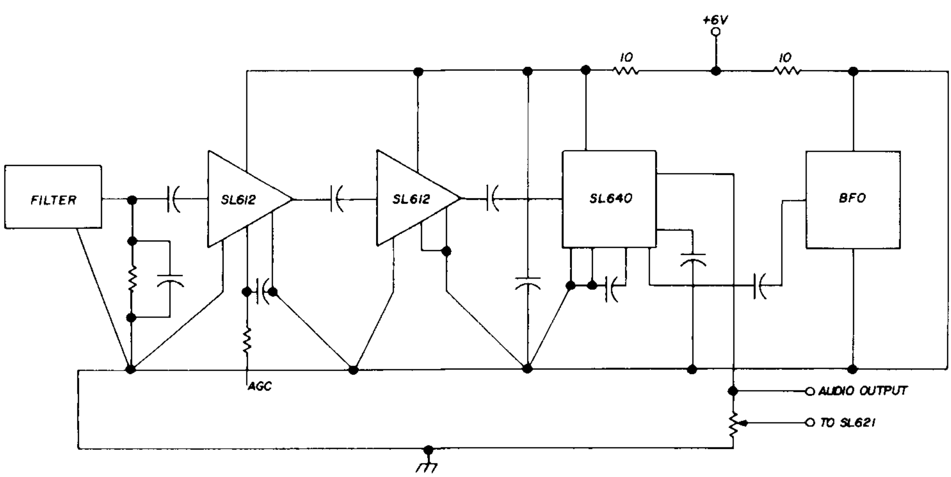

fig. 20. Proper method of grounding the ICs used in the i-f strip.

voltage-controlled gain and up to 75 mW (6-volt supply) or 200 mW (12-volt supply) output. When the SL630 is used with the SL620, which is similar to the SL621, it forms an audio agc system.[1] The SL622 is a self-contained audio agc system with an additional sidetone output which is not agc controlled. These circuits are compatible with the rest of the SL600 series, use the same power supplies and are packaged in the same T05 cases.

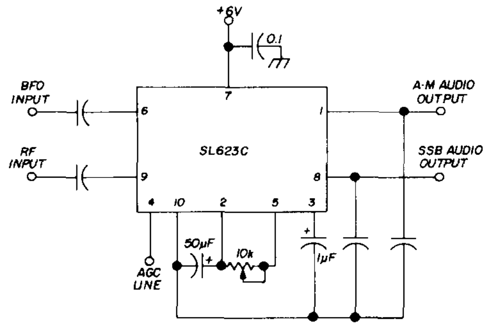

fig. 22. Suggested circuit for using the SL623C as a ssb and a-m detector.

summary

In this article I have briefly described how the Plessey SL600-series ICs can be used in high-frequency receivers, transmitters and transceivers. It can be seen that, with the exception of power amplifiers and oscillators, high-frequency transceivers can be built with SL600 devices for all functions. Vhf and uhf transceivers can be built with SL600 ICs in all but the rf and mixer stages. These modern ICs make the design and construction of a-m and ssb equipment extremely simple, and offer the home builder the opportunity to use complex, high-performance circuits which he would not consider if he were limited to individual transistor stages.

reference

1. James Bryant, G8FNT, "Miniature Microphone Preamplifier with AGC," *ham radio,* November, 1971, page 28.

ham radio

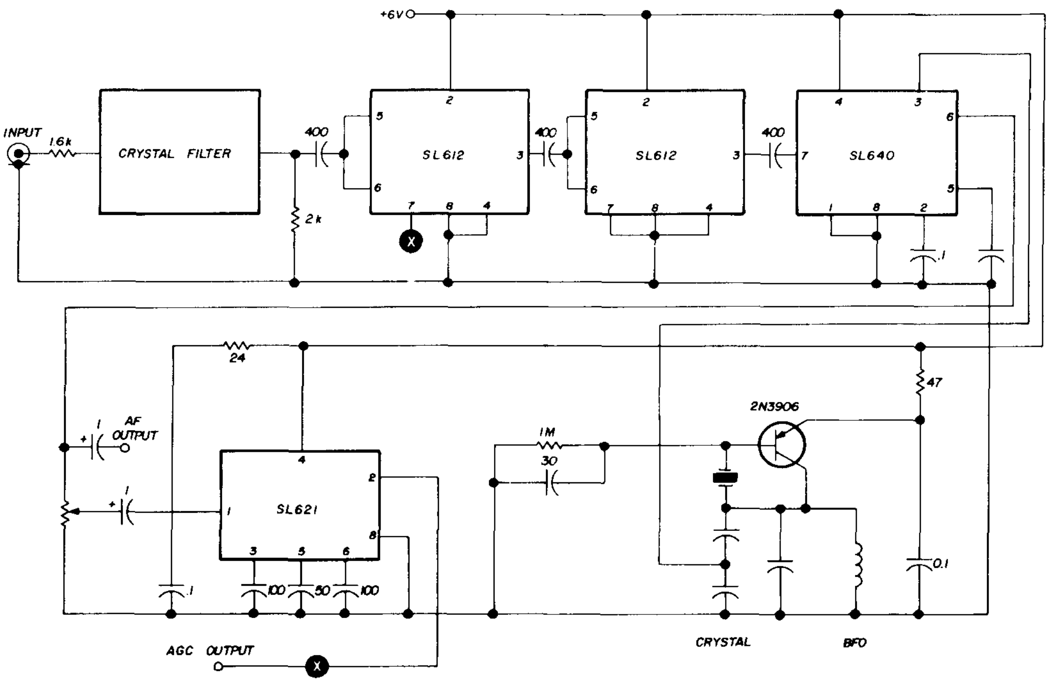

fig. 23. Complete circuit of a 10.7-MHz i-f strip, ssb detector and voice agc system.

solid-state noise blanker

Complete construction details for a solid-state noise blanker that really works

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In recent years there has been a rash of articles describing noise blankers and their virtues. Although the basic principles upon which the circuits depend are not new, the refinement of noise-blanker circuitry has come a long way with the help of modern solid-state devices.

Since I'm a homebrew nut of the first order, every time an article appeared dealing with the construction of a noise blanker, I'd drop everything and start breadboarding. More often than not, the end results left much to be desired. Usually, the old fashioned noise clipper did a better job with far fewer components. This frustration soon led me to the point where I was ready to climb the walls. Just to play it safe, I went back to building sweep generators, counters and receivers without noise blankers.

As this rest cure went into it's second year, I started to itch again. I found myself thumbing through my magazine collection and decided to give it another try.

the circuit

Nearly two years ago W2EGH described his version of a noise blanker, patterned after a vacuum-tube unit developed by the R.L. Drake Company.[1] This led me to assume that there was still hope since better brains than mine had done most of the hard part.

After the project finished me, I decided not to go back on the rest cure but to chance a few more weeks of cut-and-try orgies. In looking over some of my old notes, I came across some ideas I had tried several years ago, using the RCA CA3028 IC, which had met with moderate success. Perhaps a combination of parts from each circuit could be the answer.

The result was a noise blanker that worked. At least it did for me, and I figured it might for someone else. At any rate, I submit the circuit in **fig. 1** which consists of a slightly modified version of component delayed the i-f signal just about long enough to assure coincidence of the gating pulse with the noise pulse it is supposed to cancel. The home-brew receiver I used in my experiments fortunately had these filters between stages, and it took my nimble brain only a week or so to discover why the blanker worked when haywired into this i-f system but wouldn't work when mounted up with it's own i-f stage less the filter.

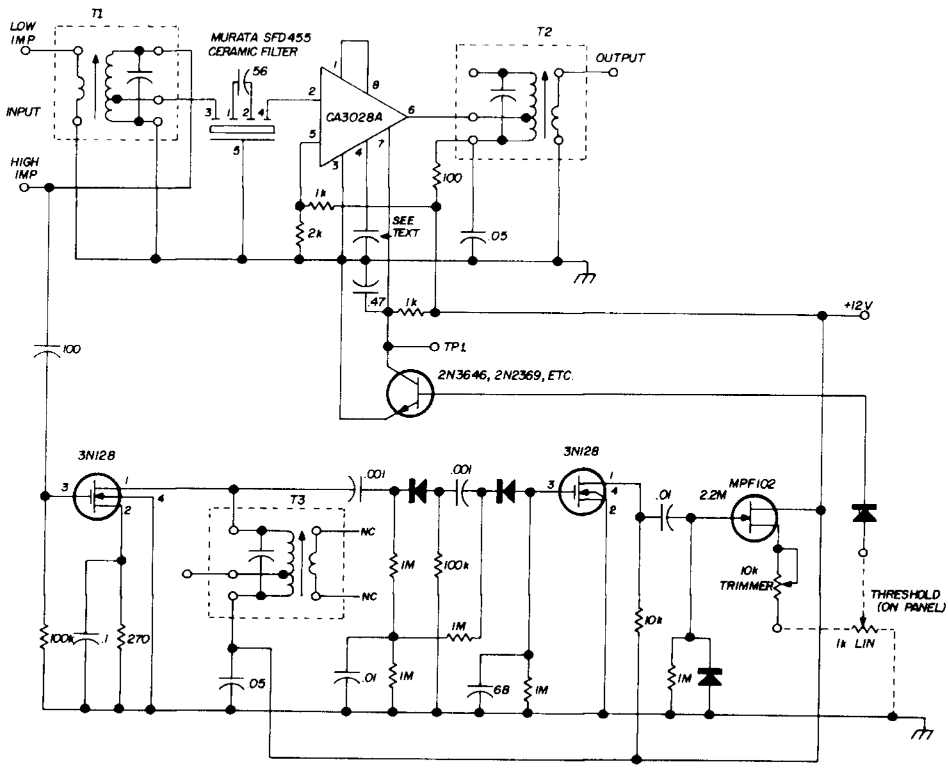


fig. 1. Circuit diagram of the solid-state noise blanker. All diodes are 1N914.

the Drake pulse-forming circuitry with an added gate transistor which shuts off the CA 3028 i-f amplifier upon receipt of a noise pulse. The blanker input is connected to the receiver mixer output and operates at 455 kHz.

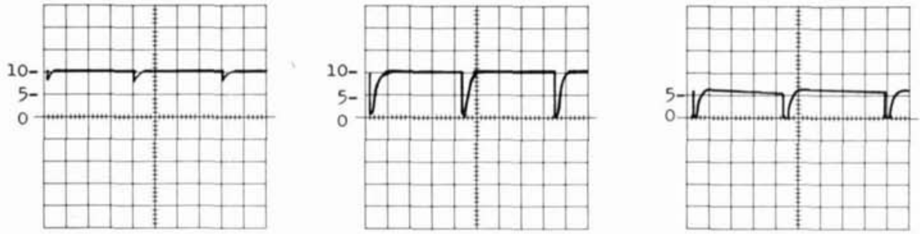
The Murata dual-ceramic filter located between T1 and the input to the CA3028 is not there to provide additional selectivity, though it does that too. It is there because I accidentally discovered that this

construction

A PC layout is shown for the benefit of those desiring to duplicate the circuit. The i-f transformers can be found hanging on pegs at your local Radio Shack store. I used white core transformers for T1 and T2. Either the black or yellow core units may be used for T3.

Use a switching transistor with low saturation voltage for the gate transistor. The 2N2369 and 2N3646 were both used here and worked well. The MPF102 fet may give some trouble due to variations in characteristics, and more than one may be needed to obtain a unit suitable for use in this circuit.

threshold control at full counter-clockwise (no blanking). With a 12-volt supply the level at TP1 should be around 11 volts. Turn the threshold control fully clockwise (maximum blanking). This may



Threshold control slightly advanced.

Threshold control about one-third advanced.

Threshold control full on.

fig. 3. Typical performance of the solid-state noise blanker.

alignment

Transformers T1 and T2 are peaked for maximum signal in the normal manner. Gain of the CA3028 i-f amplifier may be adjusted to suit your particular requirements by choice of the bypass capacitor from pin 4 to ground. If you already have sufficient i-f gain in your

or may not cause the level to drop at TP1. The desired dc level at this time is 5 volts. Use the 10k trimmer to make this adjustment. If things don't work out as prescribed, try a different MPF102.

When I first started experimenting with blankers I built an ignition noise synthesizer, and found it invaluable for

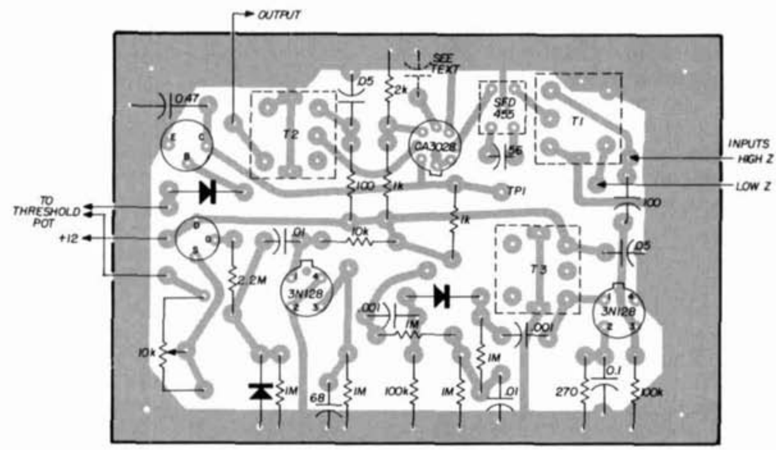


fig. 2. Full-size printed-circuit board for the noise blanker.

receiver, leave it out altogether. If you need extra gain, try values between .001 and 0,1 μF.

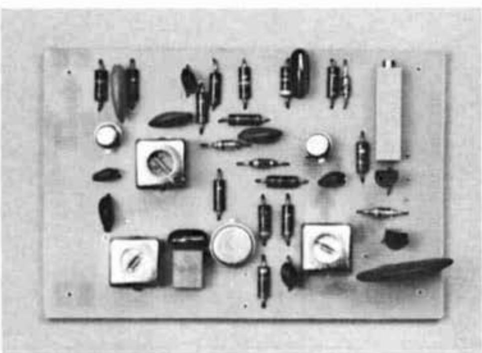
The 10k trimmer and T3 are best adjusted while observing the gate output at TP1 on a dc scope. Start with the trimmer fully clockwise and the panel

testing. However, one of the small toy battery motors at idling speed will generate some nice noise pulses for test purposes. Couple this source right to the antenna. With the threshold at minimum there should be no blanking pulses present at TP1.

As the control is advanced, negative-going pulses will appear at TP1. When these pulses stretch all the way to ground, blanking of the i-f amplifier commences. **Fig. 3** shows typical displays for various settings of the threshold control. Peak T3 for best sensitivity.

conclusion

Now that it's my turn to make brash statements, let me say that noise blanker performance on impulse noise is excellent, changing unreadable signals into perfect copy. Of course, you've heard all that before. The way I feel, though, is that if enough of this type of circuitry is published, perhaps eventually we'll be able to take the best from each and end up with what we've always considered to be the ultimate in performance, or at least a reasonable facsimile.



Overall photo of the assembly

Since some of the components may be a problem with prospective builders, I will try to help out if the demand is sufficient. I refer specifically to the Murata filter, PC board and Beckman trimmer. The rest of the components are quite common and easily obtained.

I would like to hear from anyone interested in exchanging ideas along the lines presented above – if you're not on the cure.

reference

1. Frank Van Zant, W2EGH, "A Solid-State Noise Blanker," *QST*, July, 1971, page 20.

ham radio

a simple receiver-demodulator for RTTY net operation

Some ideas for a simple but effective receiver/demodulator for unattended RTTY net operation

Larry Walrod, VE7BRK, 1644 Richter Street, Kelowna, British Columbia, Canada

As more and more amateurs become interested in radio teletype and more sequential selectors become available there is bound to be an increasing interest in 24-hour standby circuits in which any amateur, so equipped, can send RTTY to any other station on the same net. This is possible even when the receiving station's operator is away from his station. To avoid tying up the regular station equipment, it is desirable to have separate gear for the net frequency. I would like to suggest an inexpensive way to set up the receiving and demodulating functions in one unit, separate from the normal station receiver and terminal unit.

You will see in **fig. 1** that I have included all the *necessary* functions for reception and demodulation. However, I have eliminated a number of the circuits usually associated with each process by combining functions in a single unit.

After building forty ssb transceivers while on a recent five-year tour of the Republic of the Philippines, I got to respect the direct-conversion receiver. Although career commitments prevented my building a finished version of this unit, I feel confident that the design suggested here will be adequate for the intended purpose.

The circuit is easy to construct with only three rf coils and two mixer input coils. All other components are subject only to low frequencies and require no special work or critical placement on the circuit board. The design, though simple, has one advantage over many more sophisticated designs as this receiver only copies the mark and space signals. Any garbage between these signals does not get through the receiver as would be the case in a more conventional audio band pass filter type design.

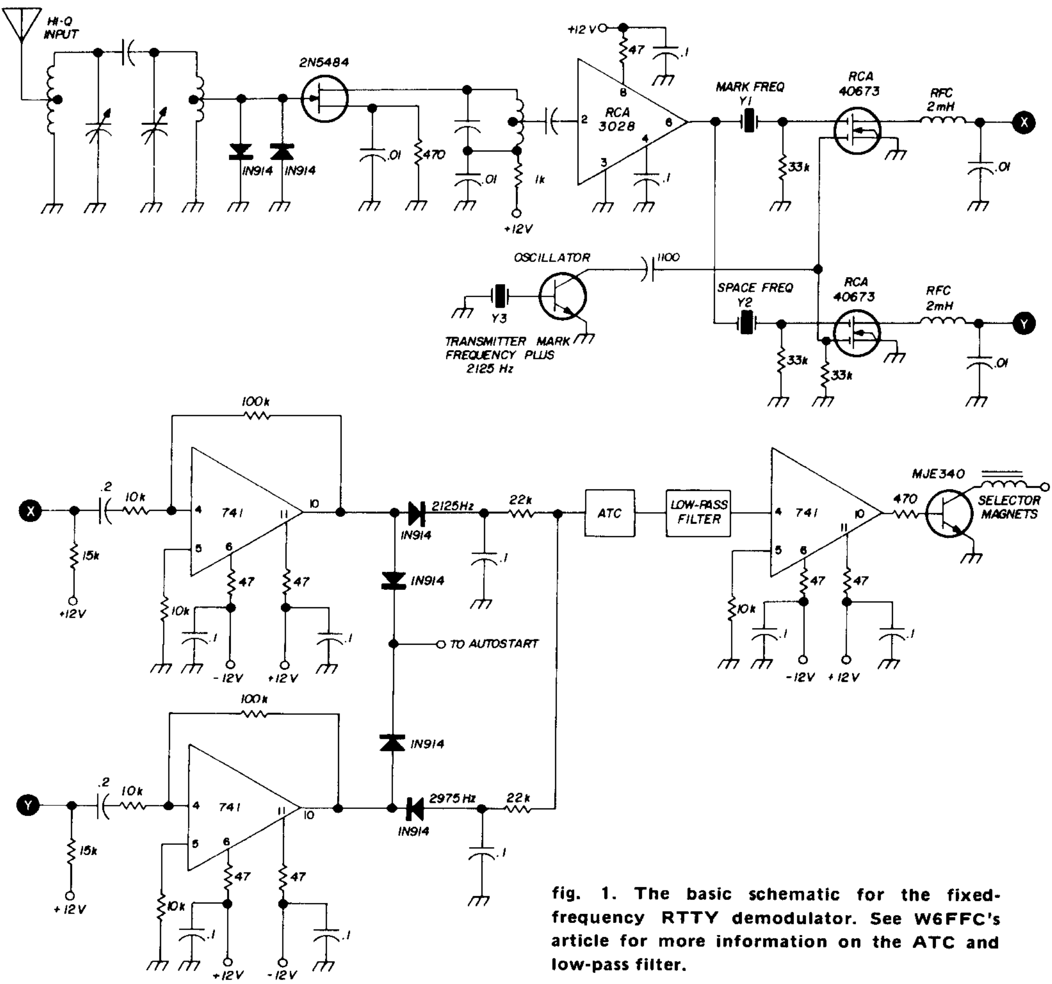


fig. 1. The basic schematic for the fixed-frequency RTTY demodulator. See W6FFC's article for more information on the ATC and low-pass filter.

crystals

It is interesting to note that the local oscillator frequency (about 2125 Hz above the transmitted mark frequency) could vary a considerable degree around the selected frequency without adversely affecting the operation of this unit. No oven would be necessary and almost any bargain priced crystal would do. This is not the case, though, with the two mark and space frequency crystals in the filters at the input to the mixers. They have to be precisely adjusted and controlled – by an oven.

The cost of obtaining accurate crystals (±20 Hz) might be a problem, but an enterprising amateur can easily get HC-6U crystals about 500 or 1000 Hz below the required frequency and put them on frequency. Remove the metal top by mounting the two pins in a vise. While grasping the top of the case with a pair of pliers have a friend play a small propane torch flame on both sides of the case. It will be only about two seconds before the solder at the base of the case is melted enough for the top to be removed (straight up to avoid damaging the crystal).

The crystal can be inserted in an oscillating circuit and the frequency can be adjusted upwards as much as 5 kHz by very easy rubbing with a little fine sandpaper mounted over the rubber

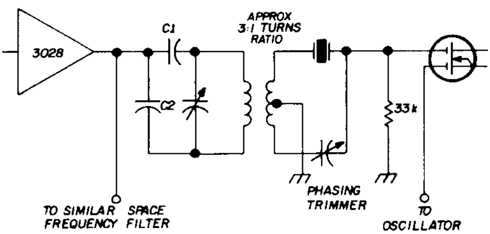


fig. 2. Suggested filter circuit for use in the circuit of fig. 1. Capacitor C1 is 15 pF and capacitor C2 is 62 pF for use on the 7-MHz band.

eraser on an ordinary pencil. Apply the sandpaper only to the plating – not on the quartz. Work a little on each side of the crystal. I have found that some crystals actually improve in activity with this treatment. Be sure to blow off any dust before making frequency checks.

Remember, though, that replacing the cover and connecting the cover to ground will have quite some effect on the final frequency. I found that grounding the case shifted the oscillating frequency of most 7-MHz crystals down about 75 Hz. If the unit is eventually to be grounded, it should be checked with the case grounded. However, when grinding and testing, you do not have to reseal the HC-6/U case each time you want to test the oscillating frequency. Just replace the cover and try it.

Also, it is not absolutely necessary to reseal the case at the end of the procedure if the crystal is going to be used in a reasonably constant atmosphere. Sealing, of course, will give far better long-term stability.

Resealing is not hard, though. There is a small vent hole near the top of the case which should be opened with a small drill and sealed *last.* Excessive heat while soldering the case to the base can lower the crystal's operating frequency by about 100 Hz. I've found a fairly effective technique is to clamp the crystal pins in a vise, install the cover (heat sinked with a large clothes pin to which a couple of brass plates have been attached) and then solder just about one quarter of the base at a time – allowing the assembly to cool between the solderings. With a little experience on this job a fellow can allow for this shift and solder the base of the case all at once (but still using the heat sink, of course). I've built about a hundred crystal filters – at first the work is very slow but it becomes easier with experience.

The balance of the circuitry is so basic and simple that it doesn't need any further treatment in this article.

reference

1. Irvin M. Hoff, W6FFC, "Mainline ST-6 RTTY Demodulator," *ham radio,* January, 1971, page 3.

ham radio

"I spent $1572.39 getting set up, and now I can't think of a thing to say."

grid-current monitor for the Heath HW-100 and HW-101

A simple circuit modification for adding a grid-current meter to your HW-100

Bob Snow, K4MFR, 713 Quarterstaff Road, Winston-Salem, North Carolina 27104

The Heath SB-line of transceivers has a meter-monitoring advantage over the less-expensive HW-100 and HW-101. It is obvious that several items have been deleted from the HW series in order to cut the price but it is not necessarily detrimental to the operation of the equipment to have fewer monitor points. It would probably be more correct to say that the SB-line incorporates some luxury features over the HW-line.

For example, the HW series uses a three-position slide switch for monitoring plate current, relative power output and ALC. This is compared to a five-position rotary switch on the SB-line which monitors ALC, plate current, plate voltage, relative power output and grid current. The HWs are missing the high voltage and the grid current measurement.

High voltage is of less importance since the power supply puts out all it can, and it's either there or it isn't! But the grid current is a good indication of ALC operation and a definite asset in tuning and alignment. You can have this monitoring point for just a little time, a little wire and a switch.

installation

By drilling a small hole in the front panel just below the meter and between the two slide switches, and installing a dpdt switch, you can effectively lift the meter out of its regular circuit and insert

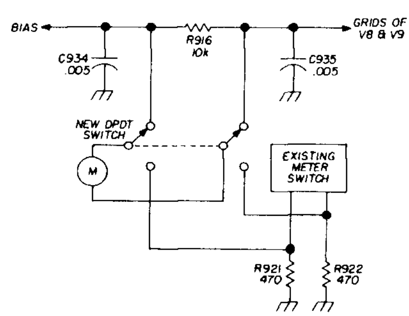


fig. 1. Grid-current monitor for the Heath HW-100 or HW-101. Only added part is S1, a dpdt switch.

it into the grid circuit as shown in **fig. 1.** Resistor R916 does not appear on a printed board. It is located on the underside of the chassis on terminal strip BR near tube V8 of the final amplifier.

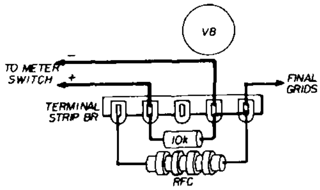


fig. 2. Location of resistor R916 under the chassis. Two new wires must be run to the added meter switch.

It is necessary to remove the cover that shields the coil assembly in order to gain access to the terminal strip. When you have located the resistor, solder a wire to each end as shown in **fig. 2.** Make sure the wires are long enough to reach to the meter. Route the pair of wires along the wiring harness, through the rubber grommet, to the other side of the under-chassis. Continue following along the harness to the front of the unit and feed the wires up through the hole in the board below the meter assembly.

Before connecting the pair of wires to the meter switch, check continuity from the resistor to code the wires for correct polarity, see **figs. 2** and **3.** Connect the wires as shown. Remove the connections from the meter and transfer them to the switch, observing proper polarity. Then connect the meter. It will be easier to make this installation if the meter is removed from the panel hole until all connections are made.

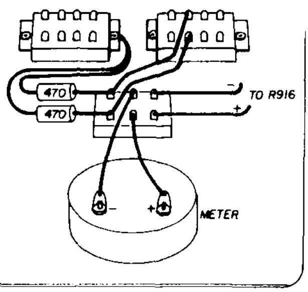


fig. 3. Modified wiring of the meter and panel switches.

The switch should be one of the miniature types, either toggle or push-button. The momentary pushbutton is perhaps the most desirable since the added circuitry is only effective with the pushbutton depressed. At all other times the circuit remains normal.

operation

With the new switch actuated, the meter indicates grid drive, which is very helpful during tuneup. The indication is much sharper than previously when the transmitter is in the *tune* position and adjustments are being made with the *drive preselector.* The grid meter also provides an indication of ALC action during ssb transmission. No grid current (except occasional peaks) will be indicated during ordinary transmission if the ALC is operating properly.

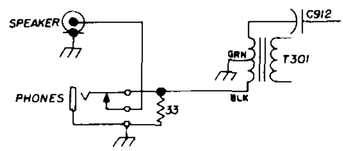


fig. 4. Simple circuit for silencing the HW-100 speaker when the headphones are plugged in.

Another annoying item in the HW-100 is the system of converting from speaker operation to headphone operation. The original circuitry connects the headphones in series with the speaker when the headphones are inserted in the phone jack. This is satisfactory as far as the headphones are concerned, but the speaker is not completely silenced. The circuit in **fig. 4** shows a quick fix. It requires a 33-ohm resistor to be added at the phone jack and a length of wire to run between the phone jack and the 8-ohm speaker jack at the rear of the chassis. Rewiring the jack and grounding the output transformer as shown does the trick.

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Hank Olson, W6GXN, Box 339, Menlo Park, California 94025

For years I have had, sitting on the floor beside my workbench, a fine old Hewlett Packard Model 300 harmonic wave analyzer. It never was really used much because more modern wave analyzers were available at work which required less nulling and twiddling. The sheer beauty of the old HP-300 in its huge varnished oak cabinet was the only thing that prevented its being scrapped out.

Finally, in desperation for more work-shop space, the HP-300 was reduced to its component parts and carefully sorted into the various bins that make up my junk box. The cabinet was even used – as firewood (it turned out to be oak *veneer*). The largest and nicest component remaining was the dial assembly, drive mechanism and dual-variable capacitor unit. This trio had originally been the tuning of the HP-300, part of a Wien bridge oscillator covering 20 kHz to 40 kHz.

The more I looked at this marvel of mechanics, the more I conjured up pictures of an all solid-state audio oscillator built around it. One fine day, the design pieces – tuning assembly, cabinet, and integrated circuits – all fit together into a generator I have sentimentally called the HO-200. The original HO-200 is shown in **fig. 1** with its old HP-300 dial (turned down to remove the original etched calibration, and so it would fit on the front panel of the Bud C994 cabinet).

Since few amateurs are likely to have an old HP-300 tuning assembly, work was undertaken to build a second HO-200 that used readily obtainable components. The dual tuning capacitor for the second unit is made by the English firm of Jackson Brothers, Ltd., and is available here.* The vernier drive was made up from an old National *Velvet Vernier,* originally stripped from a tuning unit of a surplus transmitter. Such vernier drives are quite common and are integral parts of the National ACN and MCN dials. The basic planetary drives are also available as National parts AN-250 or AVD-250. The original dial of the vernier drive was discarded and a 5-inch aluminum disc fabricated to replace it. The finished dial is very similar to that of that used on the original HO-200, as can be seen in **fig. 2.**

the circuit

The HO-200 circuit (**fig. 3**) uses modern integrated circuits for its gain blocks. The μA740 of Fairchild is an operational amplifier in monolithic form which has fet inputs. The fet input feature allows the use of the large resistance values necessary when you design for variable-capacitor tuning of a Wien bridge. The typical input impedance of a μA740 is 10^{11} ohms.

fig. 1. The original HO-200 audio oscillator used a tuning dial from an old HP-300 harmonic wave analyzer.

A low output impedance is provided by combining the μA740 with a Motorola MC1438R op amp follower. This power IC is packaged in a small diamond case for heat dissipation. The output impedance of the MC1438R is only 10 ohms, so it is capable of putting out considerable current. The MC1438R is used, as it was intended to be used, *inside* the closed loop with the op amp. (That is, the feedback to the top of the bridge is from the output of the MC1438R rather than from the output of the op amp alone.)

fig. 2. New HO-200 audio oscillator uses readily available parts.

The power supply, which provides plus and minus 15 volts, also uses an IC – a dual regulator. The Motorola MC1468G assures that the oscillator is supplied a pair of *equal,* well-regulated voltages. The 2N5191 and 2N5194 transistors associated with the MC1468G in this dual-regulator circuit pass the major part of the current, as is done in most IC regulator circuits.

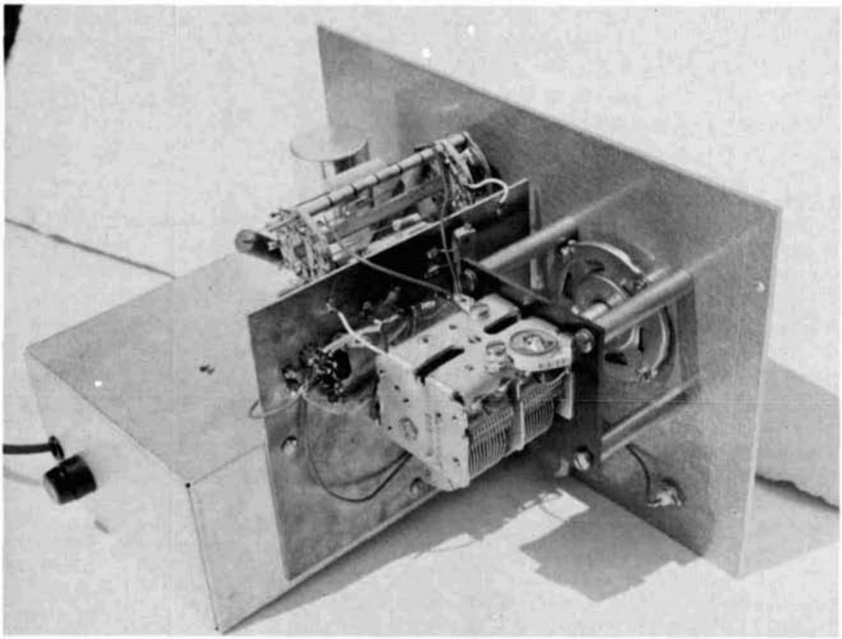
The non-linear resistance which is used to stabilize the amplitude of oscillation is not a lamp bulb, as is most common in

*The Jackson Brothers 5084/2/518H dual 518-pF tuning capacitor is available from M. Swedgal, 258 Broadway, New York, New York 10007. The price is $5.00.

Wien bridge oscillators. Instead, a thermistor is used. Of course, since a thermistor *decreases* resistance as it is heated, it must be placed in the top leg of the bridge. This is just the opposite of the lamp bulb, which *increases* resistance with temperature and must be placed in the bottom leg of the bridge. This difference is illustrated in **fig. 4.** Other such uses of a thermistor in a Wien bridge is described in references 1, 2 and 3.

Centralab PA-300 and two PA-0 sections. The two switch wafers were spaced about 2-3/4 inches apart to allow room for the resistors. These ceramic wafer-switch sections appear to be of sufficiently good insulation for use with the high values of resistance involved. If you use series resistors as I did, teflon or ceramic standoff insulators could be used for additional terminals.

Since the common terminal of the



Inside view of the audio oscillator showing the tuning capacitor, range switch and copper-clad board used as a ground plane.

construction

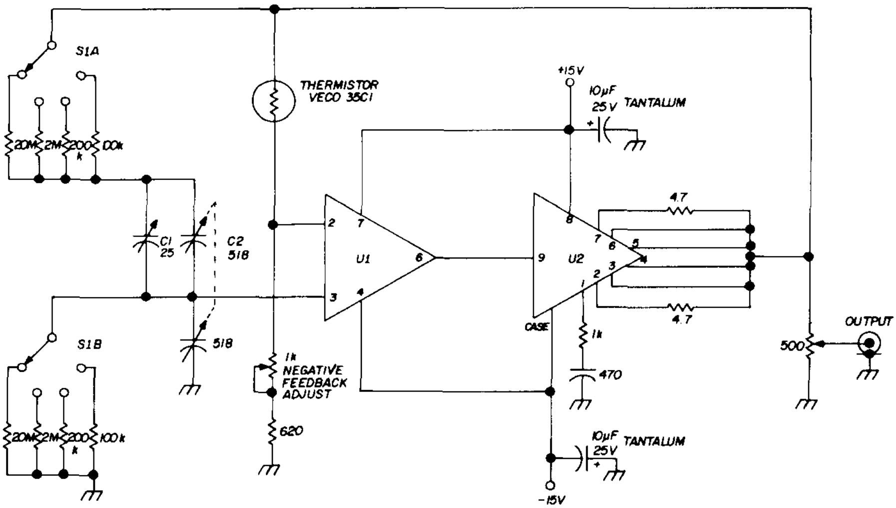
The ranges that the HO-200 will cover are 15 to 200 Hz, 150 Hz to 2 kHz, 1.5 to 20 kHz, and 3 to 40 kHz. Range switching is accomplished by changing resistance values in the positive feedback side of the bridge. It is important to use 1% resistors here; I used deposited-carbon types. I used some series pairs of resistors to make up resistance values in order to avoid buying special values.

The resistors were mounted by soldering them to the wafer terminals of a two-wafer switch assembly made up of a

dual tuning capacitor is *not* grounded, it must be mounted in such a way that it floats above ground. I accomplished this by mounting the tuning capacitor body on a square of phenolic, and using an insulated shaft coupling for tuning. The phenolic was mechanically supported by four two-inch spacers screwed to the front panel of the HO-200.

The actual oscillator circuitry was built on a piece of copper-clad laminate, such as is used to fabricate etched-circuit boards. In this case, double-sided copper-clad board was used. The part of the board that is above and next to the chassis is of special interest. One side of the laminate is at -15 volts and serves as a heat sink for U2. This "hot" portion of one side of the double-sided copper-clad laminate is isolated from the lower portion (which is bolted to the chassis) by a strip of insulation where the copper foil was peeled off. This is easily done with a rule and an X-acto knife or razor blade.

The other side of the board is entirely at ground potential and is the side toward the tuning capacitor where the bulk of circuitry is mounted. Several small insulated standoffs are used to support components on the grounded side of the board; they are fixed to the board by wetting their metal bases with solder and soldering them to the copper-foil ground plane. As can be seen from the photo of the inside of the HO-200 there are really very few components to mount; there-



C1	4.5 - 25 pF trimmer capacitor
C2	Dual 518-pF tuning capacitor (Jackson Brothers 5084/2/518HO)
U1	Fairchild µA740C, Signetics NE536T, National NH0042C or Intersill ICL8007C
U2	Motorola MC1438R or MC1538R

fig. 3. Circuit of the solid-state Wienbridge audio oscillator uses two ICs. U1 is a high input impedance operational amplifier; U2 is a low-impedance output op amp follower.

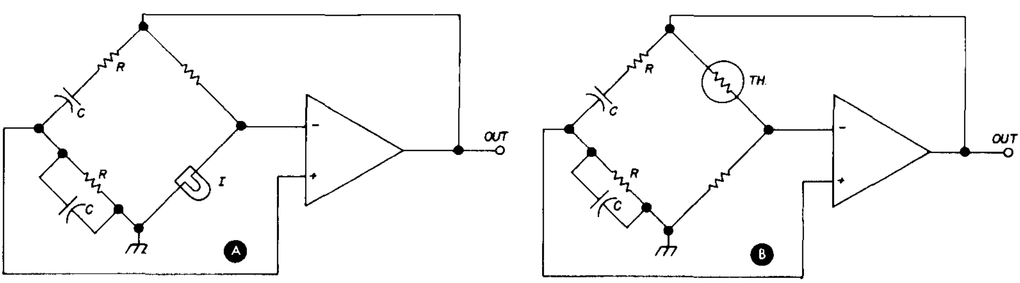


fig. 4. Use of nonlinear feedback elements in the Wien bridge circuit. The circuit in (A) uses the traditional incandescent lamp. The circuit in (B) uses a thermistor. See text.

fore, an etched circuit board was not deemed necessary.

There is one more consideration that must not be overlooked. Because the common terminal (body) of the dual tuning capacitor floats above ground, it has some finite capacitance to ground — measured to be about 10 pF in my unit. Since this is effectively in shunt with the parallel R-C branch of the bridge, a similar capacitance must be added across the tuning capacitor in the series branch of the bridge. C1 is a variable trimmer for this purpose, and should be set at about half capacitance for a start.

With the tuning dial at lowest frequency (x10 scale), measure the output voltage. Then tune to maximum frequency (x10 scale) and adjust C1 to give the same output voltage reading. The idea here is that 10 pF stray capacitance will not be much (2%) unbalance out of 518 pF at the low-frequency end (maximum capacitance), but will upset the matching of capacitance when the tuning capacitor sections are at their minimum (maximum frequency end). Therefore, C1 is best adjusted at the high-frequency end.

There is one other adjustment that can be made to the HO-200. With the output pot at maximum, you should see about 16 volts p-p at the output jack. If this amplitude is some other value, it may be adjusted by means of the trimpot in the negative feed-back side of the bridge.

The regulated power supply is entirely located on the underside of the 5x7 chassis. This is to confine 60 Hz *electric* fields so that they will not be picked up by the high impedance circuits in the Wien bridge. One electrolytic, the positive supply filter capacitor, protrudes through the top of the chassis; but its can is grounded and so has no external 60 Hz field on it. An *aluminum* 5x7 chassis is adequate here since we are only concerned with *electric* fields (not magnetic fields, too). If you want to see the great sensitivity of the circuit to stray 60-Hz fields, try operating the HO-200 out of its cabinet on the X1 scale. You will note (especially near 60 Hz and 120 Hz) severe beat phenomenon and a generally hopeless mess of waveforms.

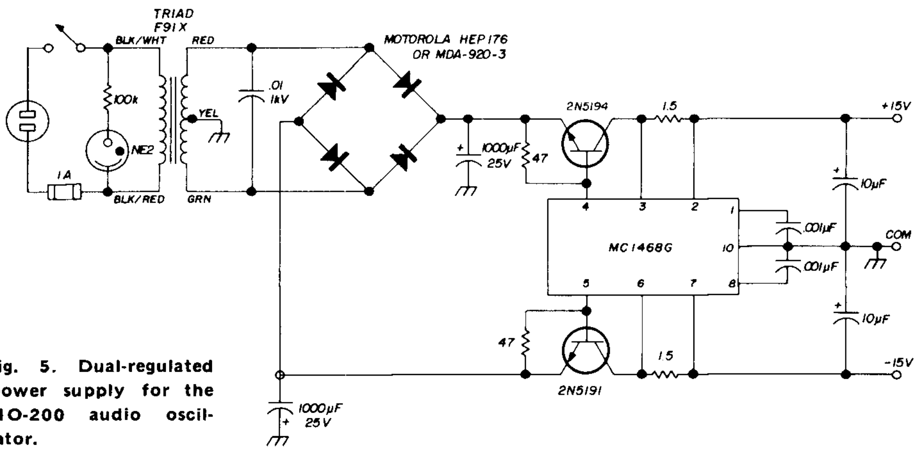


fig. 5. Dual-regulated power supply for the HO-200 audio oscillator.

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2. I.C. Zero, "Solid-State Wien Bridge Audio Oscillator," *Audio,* July, 1965, page 19.
3. H. Olson, "Dual Op Amp Makes Simple Sine-Wave Generator," The Electronic Engineer, August, 1971, page 70.

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Tuning's just part of the great adventure you'll discover when operating one of these rugged, yet stylish, new units. For instance, you'll experience the pleasures of a built-in VOX and variable controlled noise blanking. There's a minimum of front-end overload, distortion and cross-modulation. You'll find an IF derived AGC, a 25 KC calibrator, semi-CW break-in with monitor, plus WWV receive and selectable sideband operation. And all controls are out front within an easy reach.

There's more! Now you won't have to worry about burning out your final stage. These transceivers are engineered to give infinite VSWR protection from an open to a short circuit. And the receiver section uses the latest practical state-of-the-art devices including FET's, IC's and operational amplifiers. You have your choice of 15, 100, or 200 watts P.E.P. in models designed for 12 volt DC operation across the entire 80 thru 10 meter ham band. Compatible AC power supplies and a selection of style-matched accessories are available to update your station.

CHOICE OF 3 MODELS:

SWAN SS-15, 15 watt P.E.P.	**$579.00**
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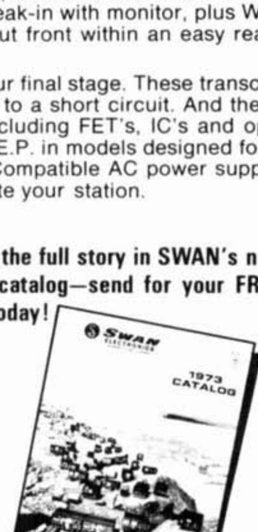
ACCESSORIES INCLUDE:

SWAN PS-10, 115V AC power supply for SS-15/SS-100	**$ 89.00**
SWAN PS-20, 115V AC power supply for SS-200/SS-100/SS-15	**$139.00**
SWAN SS-1200, 1200 watt P.E.P. Linear Amplifier (Tube Type)	**$299.00**
SWAN SS-208, External VFO	**$159.00**
SWAN 610X, Crystal Controlled Oscillator	**$ 53.95**
SWAN SS-16B, Super Selective Filter	**$ 79.95**
SWAN WM-1500, 4 scale in-line Wattmeter	**$ 49.95**

Get the full story in SWAN's new 1973 catalog—send for your FREE copy today!



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ELECTRONICS
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the ham notebook

logic test probe

As a computer engineer in a small company, I sometimes have to build my own test equipment. One of the most useful pieces I have come up with for trouble-shooting digital circuits is a test probe with memory that responds to either positive or negative going pulses and/or levels. Since I work only with TTL logic, the probe is designed to work with this. Because of the memory function, it spots the presence of single control pulses with just one operation of the circuit under test, while with a scope I have to trigger the circuit many times to clearly determine the presence of the control pulse. In addition, a high or low state is easily seen, simply by touching the desired point. It may be hard to believe, but I can go all day without ever turning the scope on.

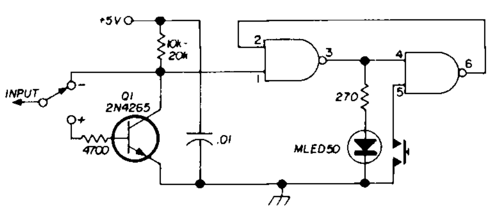

fig. 1. Circuit diagram of the logic test probe. Use IC logic of the same type you are testing, RTL, DTL, TTL, etc.

There are two switches a Memory Disable switch and a Pulse Polarity switch. Memory Disable is a push-button that resets the memory to the low state when depressed. Pulse Polarity is a toggle switch located out of the way and selects whether the probe responds to a high-level or pulse (+5v) or a low-level or pulse (ground).

The probe circuit, **fig. 1,** is simplicity itself, one TTL quad NAND integrated circuit, three resistors, one NPN Transistor, an LED and two switches. I used a 7400 integrated circuit, a motorola MILED 50 LED and a 2N4265 transistor. All parts are miniature and of high quality for reliable operation. Too much money has been spent for inexpensive parts to build test equipment that the owner ends up not trusting. Construction depends to a large degree on what you have on hand. I used a part from an old oscilloscope probe, a piece of 3/4-inch plastic tubing, and the plastic barrel from a ball-point pen with a piece of threaded rod melted into it. Conscientious workmanship is in order if you do as I did, and glue the two major parts together.

To use, connect the two power leads, and with the polarity switch set for positive pulses, touch the tip to the positive supply. The light should go on. Touching the tip to ground should not affect the light and only depressing the memory disable switch will let the light go off. With the polarity set to negative, touching the probe to the power supply should not cause an indication. The only way to get the light to light is to momentarily ground the probe tip. The only way to get the light off is to disable the memory.

In use, the memory switch can be held depressed and the probe will respond only to the level touched. If an oscillator output is probed the light will dim when memory is disabled, and brighten to full brightness when the memory disable is released. This project has proven to be a real time saver and well worth the few

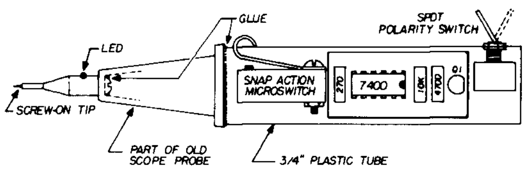

fig. 2. Construction of the logic test probe.

hours put into building it. While not everyone is deep into TTL, the applications are increasing, as I see digital repeater controls, digital circuits in RTTY applications, digital clocks, digital counters, digital volt meters and many others. This logic probe just might be the vtvm of the digital world.

Bill Rossman

frequency pre-scaler

There are a couple of things which the article on frequency scaling by F.E. Emerson in the September, 1972, issue didn't point out which may be of interest to some readers. I have been using the Fairchild 95H90 IC in a remarkably similar prescaler for some time with excellent results. My particular circuit seems to yield a little more sensitivity than Mr. Emerson observes, but perhaps I just happen to have a hotter 2N5179 in the front end.

Mr. Emerson may not have considered the consequence of using this scaler with counters that already have a good high-frequency capability such as the Heathkit IB-1101. Because the prescaler output is a square wave with quite good rise time, a counter which can count to 60 MHz or more can erroneously count the second or third harmonic of the scaled frequency. The count is reliable – it's simply wrong and is not the fault of the scaler. The simple solution to this problem is to roll off the frequency response of the scaler output. In my own prescaler I use a simple L-section filter to roll off frequencies above 30 MHz. This allows the scaler to be used up to 250 MHz and eliminates the possibility of false counting at the scaled frequency. A schematic of my own scaler, for those who are interested, is shown in **fig. 3**.

Ernie Guerri, W6MGI

telescoping tv masts

The majority of tv-type antenna masts currently on the market use a cotter pin under the bottom of each section that the upper section rests on. The cotter pin fits into a small slot in the upper section. However, there's always the possibility that the upper section hasn't seated properly during installation; if this happens the antenna will "windmill" back and forth, eventually wearing through the cotter pin.

As a safety measure a small hole should be drilled through *both* mast sections and an additional cotter pin installed. This prevents any rotation and could preclude renting a 40-foot ladder later to correct the problem.

Richard Mollentine, WAØKKC

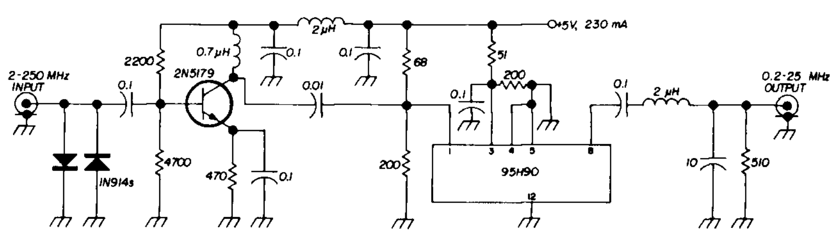

fig. 3. Frequency scaler has sensitivity of 20 mV at 175 MHz, 40 mV at 220 MHz and 90 mV at 250 MHz. All capacitors are CK06 with shortest possible leads. All unmarked pins on the 95H90 IC have no connections (do not use as tie points).

new products

rf power and vswr meter

The new Thruline® model 4342 Dual Wattmeter-VSWR Monitor displays the three prime rf transmission measurements at once on a single meter face: Forward and reflected power are indicated by individual pointers and vswr is monitored on a third scale from the intersection of the two power pointers.

Unlike most VSWR meters, the model 4342 does not require *any* adjustments to full-scale deflection, or any switching before vswr readings can be taken: The entire set of three transmission parameters is read out simultaneously during normal rf operations.

Power and frequency range of the new Bird Dual Wattmeter-VSWR Monitor depend on two plug-in elements selected from more than eighty choices available with the company's popular Thruline Model 43: Full scale power levels at ±5% accuracy range from 10 to 5000 watts for forward indication and 1 to 500 watts for reflected, in discrete frequency bands from 2 to 2300 MHz (for increased resolution, the reverse power element is ten times more sensitive than the forward power element). Model 4342 Insertion vswr in 50-ohm systems is a low 1.035 to the point of measurement. A choice of QC Quick-Change connectors permits mating with N. BNC, TNC, UHF, C, SC, LC, HN, LT, GR type 874 and 7/8" EIA lines without the need for performance-degrading adapters.

The new Bird Dual Wattmeter-VSWR Monitor is a portable instrument weighing only 5½ lbs. Model 4342 price (with female N connectors) is $265. Plug-in Elements are $30 to $75 (two required).

For more information, write to Bird Electronic Corporation, 30303 Aurora Road, Cleveland, Ohio 44139, or use *check-off* on page 94.

printed-circuit service

A valuable new service is now being offered to amateurs who build their own equipment. Most construction articles in the amateur magazines call for a circuit board. In some cases the layout is provided, but few amateurs are equipped to fabricate their own boards conveniently at home. For those who would rather concentrate on the electronics than on circuit boards, Mac McClaren, W8URX, is offering printed circuit boards, drilled and ready for parts mounting.

If he already has the artwork for the board you want, he can deliver a finished board in ten days. He offers two-week service on new items (from current magazines). He is also able to make boards

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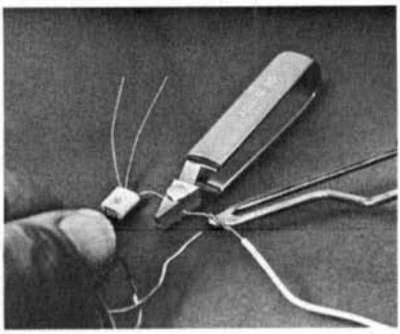
from your artwork in three weeks – write for a quote and full instructions.

All work is offered on a money-back guarantee. All shipments fob Cleveland. All boards use the very best material, G-10 epoxy, 1/16" thick with 2-ounce copper; all holes are drilled with solid carbide bits to assure burr-free holes.

For more information on this unique printed-circuit service, write to D.L. McClaren, W8URX, 19721 Maplewood Avenue, Cleveland, Ohio 44135, or use *check-off* on page 94.

heat sink



Xcelite has just introduced the no. 80 heat sink for absorption and dissipation of heat in soldering operations where adjacent, delicate electronic parts might be damaged by overheating. The manufacturer states that for optimum heat absorption and dissipation the jaws of the no. 80 heat sink are made of copper, with nickel plated surfaces to prevent solder adhesion. The spring-loaded gripping surfaces will not slip, yet have a smooth finish to prevent scratching fine wires. Exceptionally compact, this heat sink is 3-1/4-inches long in length and weighs only 1/2 ounce. An insulating cushion grip permits burn-free handling.

The no. 80 heat sink, made in the United States to highest quality standards, is now available through Xcelite's nation-wide local distributors at a list price of $2.40. Product Bulletin 5721 contains additional information, and may be obtained by writing to Xcelite Incorporated, Orchard Park, New York 14127, or by using *check-off* on page 94.

ic keyer

The new Palomar Engineers IC Keyer has been given new features while retaining those that have made it popular over the years. Its relay output suits it to key all Swan, Drake, Tempo, Yaesu, Clegg, Collins, Heath, etc., and the relay is compensated to prevent dots from getting short at high keying speeds.

Low impedance ICs are used throughout to minimize rf pickup and they are heavily bypassed to make the keyer practically rf proof. The exclusive blocking-oscillator pulse generator gives instant start and never produces an unwanted dot or dash.

Up front is the precision Brown key mechanism that is adjustable for dot and dash travel and tension. On the rear deck is an input for receiver audio so that both the received signal and the keyer monitor tone can be heard on the built-in speaker or on headphones.

The unit sells for $87.50 postpaid in USA. For more information, write Palomar Engineers, Box 455, Escondido, California 92025, or use *check-off* on page 94.

tool kit brochure

A 16-side brochure describing field engineer tool kits and cases has been published by Jensen Tools and Alloys. The brochure describes six professional tool kits, each engineer-designed to do a particular job. Included in the publication are the JTK-17 Field Engineer Kit, which contains over 100 tools in an executive attache case; the JTK-2 Electronic Technician Kit for industrial personnel; the JTK-16 Compact "Detective" Kit, which

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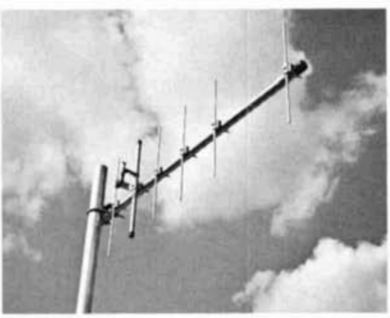
contains 30 multi-purpose tools in a zipper case; the JTK-27/37 Electronic Lab Kit, a complete portable electronics tool kit with test instruments in two attache cases; the JTK-90 Instrument Repair Kit, emphasizing watchmakers' tools; and the JTK-80 Electronic Technician Roll-Pouch Kit, a lower priced kit for technicians, students and kit builders. Kits range in price from $44.50 for the JTK-80, to $555.00 for the JTK-27/37.

A variety of cases sold separately are described and range from a canvas-like roll-pouch to the Jensen Extra-Deep Deluxe Case which features a full six-inch depth and two removable tool pallets. A total of nine cases are presented.

To receive a copy of this brochure, contact Jensen Tools and Alloys, 4117 N. 44th Street, Phoenix, Arizona 85018, or use *check-off* on page 94.

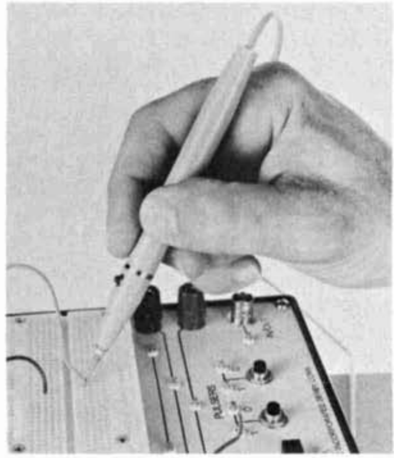
450-MHz Yagi



Cush Craft has just introduced a new six-element, rear-mount 450-MHz Yagi for amateur fm repeater operation. It can be used for control links and stations for monitor applications and access to 450-MHz repeaters. It is priced at $10.95 amateur net and exhibits 10-dB gain. It has direct 50-ohm Reddi Match feed with built-in coax fitting. The boom is 35" long and overall weight is 3 lbs. Model No. A449-6 is available through all Cush Craft distributors. The antenna is also available for commercial service.

For more information, write to Cush Craft, 621 Hayward Street, Manchester, New Hampshire 03103, or use *check-off* on page 94.

logic-tester probe



EL Instruments announced the addition to their product line of the LT-1, Logic Tester Probe. The LT-1 is a rugged, compact pencil type instrument used to determine logic levels. It operates from the dc supply of the system under test.

The logic levels are detected by an infinite life LED used as an indicator light. The LED is on at the (+) logic 1 level and off at the 0 level. The LT-1 is a high-impedance device, therefore there is no circuit loading. The frequency response is dc to 12 MHz.

The LT-1, complete with power leads, is available from stock for $11.95. Complete information and quantity prices are available from EL Instruments, Inc., 61 First Street, Derby, Connecticut 06418 or by using *check-off* on page 94.

selective call systems

Bramco Controls Division of Lederex, Inc., offers an extensive line of selective calling encoders and decoders for attachment to mobile and base station fm equipment. The line includes units compatible with GE's Channel Guard, Motorola's Private Line and RCA's Quiet Channel selective-call systems. There are also many three, five and seven digit units compatible with the Touch-Tone systems becoming more popular daily on amateur repeaters.

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The line includes a selection of mobile decoders which will activate headlights, the car horn or a latched-on signal lamp to indicate a received call while the driver is not in the vehicle. At the top of the line is a sophisticated mobile identifier system which informs the dispatcher – by means of lights and a digital readout – of the identity of the calling mobile and if the communication is routine or an emergency.

For more information on this complete line of selective calling systems write to Bramco Controls Division, Ledex, Inc., College and South Streets, Piqua, Ohio 45356 or use *check-off* on page 94.

bird wattmeter catalog

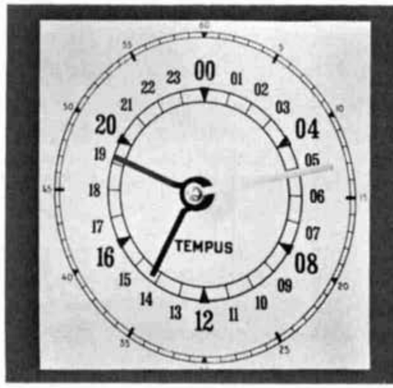
Available now is an eight-page supplement to the 1971 general catalog which lists over thirty new Thruline® rf directional wattmeters, Termaline® rf load resistors, and a 100 watt attenuator added this year by Bird Electronic Corporation, manufacturer of instruments for rf power measurement.

Shown for the first time are 75-ohm wattmeters for uhf TV and 75-ohm loads, in addition to the usual 50-ohm equipment. The brochure introduces two new product lines: A 51,000 BTU/hour heat exchanger and an instant-output wide band 150 watt rf power source. Recognizing the substantial number of radio amateurs and boating enthusiasts in the communications industry, the supplement also shows the new economical Ham-Mate® and Marine-Mate® wattmeters.

Prices are included with equipment photos and performance specifications. General Catalog Supplement GCS-72 is available free from Bird Electronic Corporation, 30303 Aurora Road, Cleveland (Solon), Ohio 44139 or by using *check-off* on page 94.

Thruline, Termaline, Ham-Mate and Marine-Mate are all registered tradenames of the Bird Electronic Corporation.

two time-zone 24-hour clocks



Tempus Instrument Corporation has introduced a 24-hour clock, powered by a high-quality four-jewel battery-operated clock movement made in West Germany. One regular C-size flashlight battery runs the clock for at least 18 months. The case is of scratch-resistant Acrylic material measuring 6 x 6 x ½ inches.

Three multi-colored hands permit simultaneous reading of hours and minutes 24 hours a day in *two* different time zones of the world. This feature makes the clock especially useful for amateur radio operators. Each clock comes with a hanger and with an aluminum bracket for use as a wall clock or desk clock.

Tempus also offers a similar model as a plain 24-hour clock with sweep second hand. All products are fully guaranteed for one year and sell for $29.50. Additional information is available from Tempus Instrument Corporation, Villa Italia Center, Suite 594, 7200 West Alameda Avenue, Denver, Colorado 80226 or by using *check-off* on page 94.

radio shack catalog

Radio Shack's new 1973 electronics catalog features the company's complete line of experimenter's components, Realistic home entertainment products, audio equipment and Citizen Band equipment, Micronta test instruments, Archer antennas, and Archerkit and Science Fair electronic and hobby kits.

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The 180-page catalog, with more than half of its pages in full color, lists thousands of electronic items such as tubes, transistors, cables, tools, connectors, wire, plugs and adapters for amateurs, hobbyists, experimenters, technicians or anyone wanting a wide selection of parts, accessories and maintenance items.

Among the products being introduced as new for 1973 are stereo and four-channel amplifiers, receivers, adapters and tape decks; speaker systems, CB radios, Archerkits, Science Fair Lab kits, stereo radios, scanning monitor receivers and a miniature electronic calculator.

Catalog 227 is available free on request from any of Radio Shack's more than 1500 stores in all 50 states and Canada, or by mail from Radio Shack, Department R-26, 2617 West Seventh Street, Fort Worth, Texas 76107 or by using *check-off* on page 94.

crt terminals

A new data sheet describing the Series 200 Video Terminal Controllers, free-standing keyboards and monitors is available from Ann Arbor Terminals, Inc. The new literature emphasizes the application of Series 200 crt units in conjunction with, or as substitutes for hardcopy print-out terminals.

Features of the Series 200 equipment include noiseless operation, preview and editing capability, very high speed and exceptional reliability – features not available on electromechanical data capture terminals. Other features of Ann Arbor's line are compatibility with existing keyboards and data capture terminals and the capability for driving multiple standard TV sets or 525-line video monitors. There are many units in the line ranging from $795 to $1195 in single quantities.

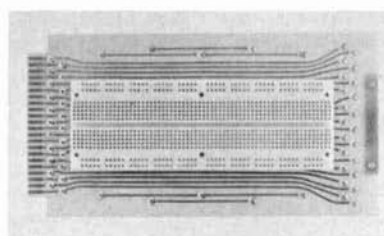
For the new data sheet write to Ann Arbor Terminals, Inc., 6107 Jackson Road, Ann Arbor, Michigan 48103 or use *check-off* on page 94.

sub-audible tone encoder/decoder

Alpha Electronic Services has announced a new two-frequency subaudible tone encoder/decoder; the model DTSS-80 continuous-tone squelch system is exceptionally useful where a need exists to have a choice of tone frequencies for the purpose of controlling or selecting repeater stations, base stations or mobile radio units. By a simple two-position switch the dual tone makes possible the employment of multiple repeaters, increasing the range capabilities of a radio communications system. The selective calling of two base stations, two groups of mobiles or special control functions are other uses that this versatile device can accomplish. Each DTSS-80 tone unit is comprised of a plug-in encoder/decoder board and two plug-in TN-91 frequency determining boards. A special model is available that plugs directly into General Electric Master mobile radio units.

For information on the DTSS-80 write to Alpha Electronic Services, Inc., 8431 Monroe Avenue, Stanton, California 90680, or use *check-off* on page 94.

plug-in socket boards



EL Instruments announces the PL-1 and PL-2, Plug-in Socket Boards. The PL-1 and PL-2 feature one or two patented EL SK-10 component sockets on a 4½ x 9 inch glass epoxy G10 pc board.

The board includes a 22 pin card edge connector and card extractor handle. There are also 44 BP-23, breadboarding pins on the board for connecting the devices on the SK-10 sockets to the card

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edge connector. There is no soldering required; connections are made with standard 22 or 24 AWG hook-up wire.

The PL-1 and PL-2 are card rack compatible and have top edge test points for ease in circuit checking. The boards can be used to test prototype designs, add to existing card rack systems, update old pc card designs and many other breadboarding functions.

The PL-1 (two SK-10 sockets), at $42.50 and the PL-2 (one SK-10 socket) at $29.95 are available from stock. Complete information and quantity prices are available from EL Instruments, Inc., 61 First Street, Derby, Connecticut 06418 or by using *check-off* on page 94.

standard tone burst encoder

Standard Communications Corporation has introduced the new SC-ATBE-1 five-frequency tone burst encoder for activation of coded repeater systems. The unit offers exceptional stability of ±0.25% over a 180° temperature range through the use of a bridged-T oscillator and quality mica capacitors. The unit comes factory preset for the five most commonly used burst tone frequencies in the 1700 to 2500 Hz range – although the frequencies can be easily changed at any time.

The burst duration can be set from 0.1 to 1.0 seconds or keyed continuously by a front panel control for testing. Units come factory preset for 0.4 seconds. Output up to 15 mV rms, sine wave, is internally adjustable for different rigs with units coming preset for use with the SR-C826M. The unit styled to match the SR-C826M, mounts under the SR-C826M and plugs directly into the rear of any Standard Communications Corporation transceiver (except the hand-held units). The unit is powered by the standard 12 Vdc. It sells for $78.00.

More information is available from Standard Communications Corporation, 639 North Marine Avenue, Wilmington, California 90744 or by using *check-off* on page 94.

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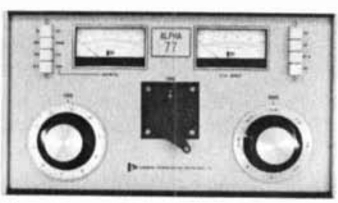

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TX100	$109.95	KR20	$ 59.95
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CLEGG FM-27B NO XTALS
25w out Synthesized
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MP1 mobile supply .... good, $ 95.00
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SB-36 5 Band 500W SSB/CW Digital readout transceiver complete with AC power supply Brand new in stock, Write

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GR 1001A SIGNAL GEN .... good, $425.00
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MODEL 102, is a 4 amp overload protected power supply that automatically resets itself when the overload is removed .... new, $24.95

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MODEL 612 is a special purpose unit to provide 12 VDC negative ground power in automobiles with either 6 volt negative ground or 12 volt positive ground. 10 amp surge, 3 amp continuous .... new, $22.95

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TOP QUALITY...WITH THE HAL 1550 ELECTRONIC KEYER. Designed for easy operation; perfectly timed CW with optional automatic ID for sending call letters, great for DX and RTTY; TTL circuitry, transistor switching for grid block, cathode keying. Handsome rugged crackle cabinet with brushed aluminum panel. With ID, only $90.00; without ID, $65.00.*

OTHER HAL PRODUCTS INCLUDE:

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TOP QUALITY... WITH THE HAL MKB-1 MORSE KEYBOARD. As easy as typing a letter—you get automatic CW with variable speed and weight, internal audio oscillator with volume and tone controls, internal speaker, and audio output jack. Smooth operation; completely solid-state, TTL circuitry using G10 glass boards, regulated power supplies, and high voltage transistor switch. Optional automatic ID available. Assembled MKB-1, $275.00. In kit form, $175.00.*

NEW FROM HAL—TOP QUALITY RVD-1002 RTTY VIDEO DISPLAY UNIT. Revolutionary approach to amateur RTTY . . . provides visual display of received RTTY signal from any TU, at four speeds (60, 66, 75, and 100 WPM), using a TV receiver modified for video monitoring. Panasonic solid-state TV receiver/monitor, or monitor only, available. RVD-1002, $525.00; Panasonic TV receiver/monitor, $160.00; monitor only, $140.00.*

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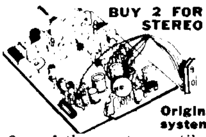
11 TRANSISTOR PHILCO AM RADIO CHASSIS



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- **Covers 555 Kcs to 1500 Kcs Broadcast band**
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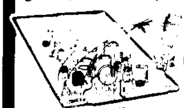

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100	☐ .35	☐ .52	☐ .64	☐ .85	☐ 1.05
200	☐ .65	☐ .72	☐ .88	☐ 1.25	☐ 1.45
300	☐ .79	☐ .89	☐ 1.10	☐ 1.45	☐ 1.65
400	☐ .92	☐ 1.15	☐ 1.35	☐ 1.85	☐ 1.95
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Code: 3 & 6 amp TO-5, 10 amp TO 66, 15 & 25 amp stud.

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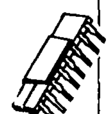

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6.3	11.	30.
8.2	12.	33.
9.1	13.	

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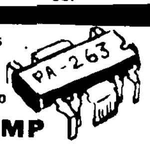

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Includes SN7490, decade counter, SN7475 latch, SN7441 BCD decoder driver, 0-to-9 Nixie tube, instructions.

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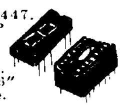

0-9 plus letters, for SN7446 or SN7447. Snaps in 14-pin DIP socket. ¾x⅜x⅜", characters: ¼x³⁄₁₆". 5V, 20-mils per seg. characters: ¼x3/16" Famous MAN-1 type.
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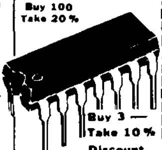

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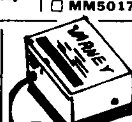

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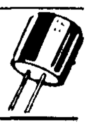

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PIV	2Amp*	2Amp	3Amp
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200	.07	.07	.15
400	.09	.09	.22
600	.12	.12	.28
800	.15	.15	.39
1000	.18	.18	.45

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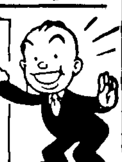
☐ **1 AMP 1000 PIV**



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N.F. (typical)	2.5dB	2.8dB	3.4dB	3.8dB	COMING
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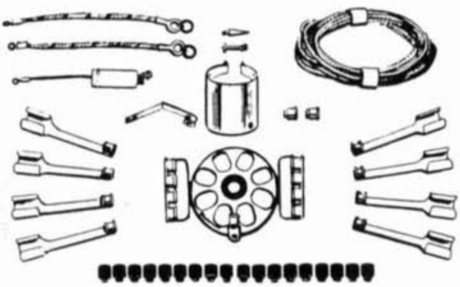

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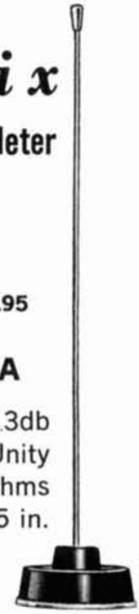

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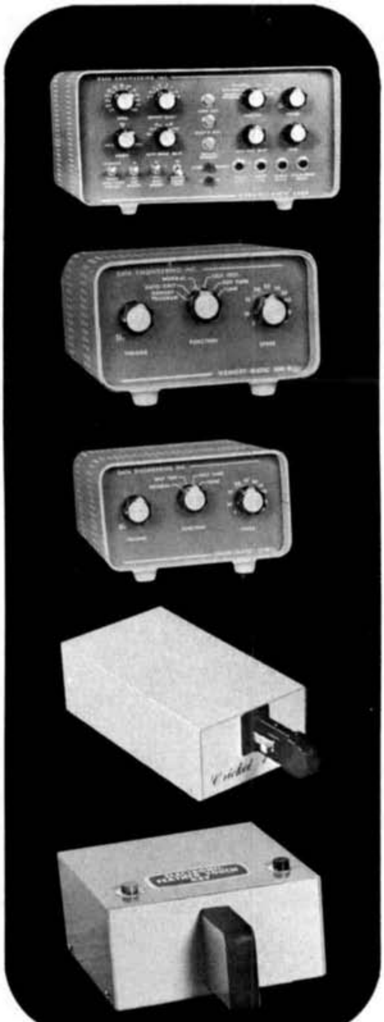

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WANTED: tubes, transistors, equipment what have you? Bernard Goldstein, W2MNP, Box 257, Canal Station, New York, N. Y. 10013.

22nd ANNUAL DAYTON HAMVENTION will be held on April 28, 1973 at Wampler's Dayton Hara Arena. Technical sessions, exhibits, hidden transmitter hunt, flea market, and special program for the XYL. For info write Dayton Hamvention, Dept. H, Box 44, Dayton, Ohio 45401.

WORLD QSL — See ad page 92

TECH MANUALS for Govt. surplus gear only $6.50 each: R-388/URR, R-389/URR, R-390/URR, URM-25D, RCK, TT-63A/FGC, CV-591A/URR, TS-497B/URR, TS-34A/AP, R-220/URR. Hundreds more. Send 50¢ (coin) for 20-page list. W3IHD, 4905 Roanne Drive, Washington, D. C. 20021.

UHF FET PREAMPLIFIER. 440-470 MHz. Mobile or fixed. At least 6db gain (10db typical). Power source +10V to +15V. 10ma drain or less. RCA phono type jacks. 1½ x 1½ x 1¾ inches, fully shielded. Price includes taxes. $18.00 Prepaid U.S.A. Electronics Enterprises, 6606 Fifth Street, Rio Linda, Ca. 95673. (916) 991-2010.

TUBES save $$$$$ send RFQ: Tubes International, Wainright, Ak. 99782.

TOROIDS, iron "E" powder 80-10 meters. .500" — 8/$1.00, .940" — 4/$1.00, 1.437" — 75¢ each or 3/$2.00, 2.310" — $1.50 or 3/$4.00. Please include 50¢ postage, slightly more on large orders. Fred Barken, WA2BLE, 274 E. Mt. Pleasant Ave., Livingston, N. J. 07039.

ROCHESTER, N. Y. is the place to go for the largest Hamfest, VHF meet and flea market in the northeast, May 12th. Write WNY Hamfest, Box 1388, Rochester, N. Y. 14603.

2N3632's BRAND NEW, $2.50 each, three for $7, WA2KOI, L. Schoenig, 207 Woodlawn, Williamstown, N. J. 08094.

SP200 RECEIVER with power supply in running condition. $50.00 or best offer. Other items for sale or trade also. Mike Kane, WA1PJG, 50 South Porter, Manchester, N. H. 03103, 603-622-5320.

REPAIR TV TUNERS — High earnings, complete course details, 12 repair tricks, many plans, two lessons, all for $1. Refundable. Frank Bocek, Box 3236 (Enterprise Branch), Redding, Ca. 96001.

SELL: ART-13, 2-18MHz, 200W A1A3 with P. S. No shipping. $60. Chas. Wallace, W1IIB, 8 Elaine St., Hampton, N. H. 03842.

USED MYLAR TAPES — 1800 foot. Ten for $8.50 postpaid. Fremerman, 4041 Central, Kansas City, Mo. 64111.

HOLIDAY 1973, destination Southern Ireland. Exchange unwanted gear for guesthouse accommodation. Pursue hamming, fishing, sport, recreation interests. Des Walsh, EI5CD, Ballylynch Carriek-on-Suir, Ireland.

SAVE MONEY on parts and transmitting-receiving tubes. Foreign-Domestic. Send 25¢ for giant catalog. Refunded first order. United Radio Company, 56-HR Ferry Street, Newark, N.J. 07105.

SALES: COLLINS CC-3 CARRYING CASES for KMW-2 Power Supply and/or other accessories. Excellent condition. $20 each FOB origin. Only 8 available. Money order or certified check to Oleg Kolen, W7LU, 2916 Oriole Drive, Sierra Vista, Ariz. 85635.

WANTED: JULY 1969, Ham Radio magazine. Andy Kalayta, 7645 N. Crawford, Skokie, Illinois 60076.

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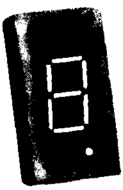

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LM370	AGC/Squelch amp	**$4.85**
LM373	AM/FM/SSB IF strip/Det	**$4.85**
LM309K	5V 1A regulator. If you are using TTL you need this one.	**$3.00**

POPULAR IC's

MC1550	Motorola RF amp	**$1.80**
CA3020	RCA ½ W audio	**$3.07**
CA3020A	RCA 1 audio	**$3.92**
CA3028A	RCA RF amp	**$1.77**
CA3001	RCA	**$6.66**
MC1306P	Motorola ½ W audio	**$1.10**
MC1350P	High gain RF amp/IF amp	**$1.15**
MC1357P	FM IF amp Quadrature det	**$2.25**
MC1496	Hard to find Bal. Mod.	**$3.25**
MFC9020	Motorola 2-Watt audio	**$2.50**
MFC4010	Multi-purpose wide-band amp	**$1.25**
MFC8040	Low noise preamp	**$1.50**
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FET's

MPF102	JFET	**$.60**
MPF105/2N5459	JFET	**.96**
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MFE3007	Dual-gate	**$1.98**
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MC724	Quad 2-input RTL Gate	**$1.00**
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MC790P	Dual J-K Flip-flop	**$2.00**
MC799P	Dual Buffer RTL	**$1.00**
MC780/880	RTL decade counter	**$3.00**
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Silicon voltage variable capacitance diodes in TO-92 plastic case like plastic transistors. Both standard Motorola and HEP numbers are listed: devices are same. Capacitance value is typical at —4Vdc. Tuning ratio is approx. 3:1.

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MV2103/R2501	10 pF	**$1.10**
MV2105/R2502	15 pF	**$1.10**
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MORE RCA IC's

CA3088E	AM rcvr subsystem	**$2.50**
CA3089E	FM IF system with circuits for IF amp., Det., AF preamp., AFC, Squelch, & tuning meter	**$3.90**
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NEW FAIRCHILD ECL HIGH SPEED DIGITAL IC's

9528	Dual "D" FF toggles beyond 160MHz	**$4.65**
9582	Multi-function gate & amplifier	**$3.15**
95H90	300 MHz decade counter	**$16.00**

A 95H90 & 9582 makes an excellent prescaler to extend low frequency counters to VHF — or use two 9528s for a 160 MHz prescaler.

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Please add 35¢ for shipping

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More Details? CHECK—OFF Page 94

MODERNIZE FOR PEANUTS! Frame & Display QSL's with 20 pocket plastic holders. Two for $1.00, seven for $3.00. Prepaid, guaranteed. Universally used and approved. Order now. TEPABCO, Box 198H, Gallatin, Tennessee 37066.

PRINTED CIRCUIT DRILL BITS. Trumbull, 833 Balra Drive, El Cerrito, California 94530.

WANTED: GOOD MODEL 19 RTTY. Quote price delivered to my QTH. Cline, Box 216, Logan, Utah 84321.

FOR SALE SB 401 excellent, on 80-10. Going MARS. $240. UHF AMP Dumont with 2 new 4cx250K's. 50¢ for photo. $150. AL K4AVQ/3, 20 Lepore Dr., Lancaster, Pa. 717-392-4237.

FIGHT TVI with the RSO Low Pass Filter — p115 March 73 — write for brochure — Taylor Communications Manufacturing Company, Box 126, Agincourt, Ontario, Canada.

SURPLUS MILITARY RADIOS, Electronics, Radar Parts, tons of material for the ham, free catalogue available. Sabre Industries, 1370 Sargent Avenue, Winnipeg 21, Manitoba, Canada.

TECHNICAL MATERIEL CORPORATION GOODIES, TRC-500 antenna coupler $27.50, FFR receiver (with all heads) $100.00, AKT-7 100W 220MHz amplifier $30.00, TS-497B $150.00, TS-382D $50.00, much more, SASE for 5 page list. Wanted: E and E Radio Handbooks, 14th Edition and earlier, 2M walkie, GPR-90/GSB-1 receiver. Richard Solomon, 5 Cherry St., Lexington, Massachusetts 02173.

SCALERS — Complete units. 260MHz unit $70; high sensitivity 280MHz unit $90. Add Calif. tax and $1.50 shipping. Guaranteed. W6PBC, Belmont Spectrum Research, 1709 Notre Dame, Belmont, Calif. 94002.

WE BUY ELECTRON TUBES, diodes, transistors, integrated circuits, semiconductors. ASTRAL ELECTRONICS, 150 Miller Street, Elizabeth, N. J. 07207. (201) 354-2420.

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QSL'S — BROWNIE W3CJI — 3111B Lehigh, Allentown, Pa. 18103. Samples 10¢. Cut catalogue 25¢.

TELETYPEWRITERS — Kleinschmidt — portable, fixed, sets, punches, parts, reconditioned, reasonable. Mark/Space Systems, 3563 Conquista, Long Beach, Calif. 90808. 213-429-5821.

F.C.C. TYPE EXAMS GUARANTEED to prepare you for the F.C.C. 3rd., ($7.00), 2nd. ($12.00), and 1st ($16.00), phone Exams; complete package, $25.00. Research Company, Dept. D. Rt. 2, Box 448, Calera, Alabama 35040

CANADA'S MOST UNUSUAL Surplus and Parts Catalog. Jam packed with bargains and unusual items. Send $1. ETCO-HR, Box 741, Montreal, Canada.

1973 DESK CALENDAR, 12 x 9. Name, address, call in gold, $2.00. Henry Morgan, 883 Diana, Akron, Ohio 44307.

RESISTORS: Carbon Composition brand new. All standard values stocked. ½ watt 10% 50/$1.00; ¼ watt 10% 40/$1.00. 10 resistors per value please. Minimum order $5.00. Post paid. Pace Electronic Products, Box 161-H, Ontario Center, New York 14520

RECIPROCATING DETECTOR KIT. Send SASE to, Peter Meacham Associates, 19 Loretta Road, Waltham, Mass. 02154.

RTTY SPEED CONVERTER. A drilled 4" x 6½" PCB and all components except input ouput jacks, power supply and chassis. See Dec. '71 and Oct. '72 issue of Ham Radio. $40.00 postpaid. PCB only $6.00. P & M Electronics, Inc., 519 South Austin, Seattle, Washington 98108.

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Checked and ready to operate on the landline-or on the air. Contains receiving and transmitting AFSK units.
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NEW 3GP1 SCOPE TUBES (Similar to 3AP1) $3.00 ppd US.

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Completely transistorized, compact, portable. Capacity for 6 channels. Built-in telescoping antenna, and connector for external antenna. Use barefoot or with accessory amplifier. External 12 VDC or internal ni-cad batteries, built-in 120 VAC battery charger.

GENERAL: • Freq. coverage: 144-148 MHz • 6 channels, 3 supplied • Push-to-talk Xmit • DC Drain: Rcv, 45 mA; Xmit, 450 mA • Size: 5-3/8" x 2-5/16" x 7-1/8", 3-3/4 lbs.

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TRANSMITTER • RF Output over 1 W • Freq. Dev. adj. to 15 kHz max., factory set to 5 kHz.

Complete with: Dynamic Mike, O-T-S Carrying Case, 120 VAC and 12 VDC Cords, Speaker/Headphone Plug and 10 Ni-Cad Batteries.

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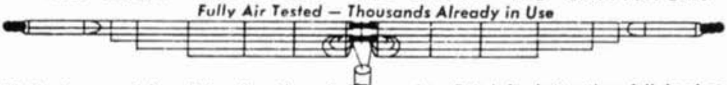

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More Details? CHECK—OFF Page 94

MEASUREMENTS CORP. MODEL 80, 2-400MHz. Mint. $150, will deliver. Also audio sig. gen., audio triggered scope. Ten-Tec RX10 $25, QRP rig. Eric, K1PCT, 617-646-6631, eves.

NOVICES: Heath DX-60A transmitter, HG-10B VFO, Lafayette HA-350 receiver, all for $150.00. will throw in all cables and T/R switch for complete setup. Mike, WA2IMC, 248 Bay Avenue, Patchogue, N. Y. 11772. Landline 516-475-8454.

HELP! Need HR March '70, '71. QST Jan, Feb., '62; July, Aug., Oct., Nov., '65; Feb., Nov., '66. Can swap with any other copy of HR or how much. Eskil Persson, SM5CJP, Frotunagrand, 1,S-19400 Upplands Vasby, Sweden.

VHF NOISE BLANKER — See Westcom ad in Dec. '70 and Mar. '71 Ham Radio.

THE LaPORTE, INDIANA AMATEUR RADIO CLUB will hold it's Annual Swap-fest and Auction on the 4th of February, 1973, beginning at Noon. Location is the Civic Auditorium, and there will be talk-in on 94, 22-82 and 3910 kHz.

NEW SCANNER BOOK from Sams. Includes comprehensive servicing data for 30 popular UHF and VHF Scanner - Monitor receivers including models by B & K, Browning, Johnson, Midland, Pace, Pearce-Simpson, Penney's, Realistic, Sonar and Teubury. Just $4.95 postpaid from Comtec, Greenville, N. H. 03048.

TEXAS VHF-FM SOCIETY 1973 winter meeting in Brownsville February 24 and 25 at Fort Brown Hotel. Submit your reservation request now so that you may be assured of a room as space is at a premium. On Saturday afternoon, especially for the ladies, there will be a guided sight-seeing and shopping tour of Matamoros. It will be a great meeting. There will be some excellent technical talks and an in-depth discussion of the new repeater rules. For details contact Art Ross, W5KR, Meeting Coordinator, P. O. Box 3561, Brownsville, Texas 78520.

THE LAKE COUNTY (Indiana) Amateur Radio Club, Inc., proudly announces its 20th annual Radio Club Banquet to be held at the Scherwood Club, 600 East Joliet St., Schererville, Ind. The date is Saturday, February 10, 1973, and the affair starts promptly at 6:30 p.m., CST. Awards, music, speeches, food — all you can eat — entertainment, good fellowship. Bring your wife, family, or girlfriend. Tickets are $5.00, each, and are available from Herbert S. Brier, W9EGQ, 385 Johnson St., Gary, Indiana 46402, or from other club members. Positively no tickets sold at door.

SOME MEMBERS of the Aircraft Owners and Pilots Association (AOPA) are organizing a society of "Flying Hams," to be roughly similar to other flying groups such as the Flying Doctors, etc., the purpose being to combine the two great activities of flying and hamming for mutual benefit and public service. Fly-ins and nets will be part of the activity and the use of flying repeaters has been mentioned. Additional information can be obtained from Dick Ertman (AOPA 329499), 94 Spruce Street, Apponaug, Rhode Island 02886. Comments are welcomed.

SURPLUS CERAMIC 7289 (3CX100A5) and glass 2C39A tubes. Prechecked 449mc, guaranteed ICAS. $3 ea., $30 doz., plus postage. Ed Howell W4SOD, Folly Beach, S. C. 29439.

GREATER BALTIMORE HAMBOREE, Sunday April 8 at 10 a.m., Calvert Hall College, Goucher Blvd. and LaSalle Road, Towson, Maryland 21204 (1 mile south of Exit 28 Beltway-Interstate 695), Food Service, Prizes, Flea Market, registration $2.00. No table charge or percentage. INFO. Contact W4WVC at school address.

NEED IMMEDIATELY: 2 J-28 and C-42/ARC-5 junction & control units. Also wanted, 2 FT-220A & MT-71 mounting racks; Write WB8NLM, 146 Schonhardt St., Tiffin, Ohio 44883.

YOUR AD belongs here too. Commercial ads 25¢ per word. Non-commercial ads 10¢ per word. Commercial advertisers write for special discounts for standing ads not changed each month.

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MODEL 10 • KEYER
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No bulky batteries or awkward power cords with the Model 10 Keyer. Internal penlight cells and reed relay output produce a compact, portable, and versatile unit. Also available as a circuit board kit without case for custom installation.

Keyer Kit	**$21.90**
Keyer Assembled	**$26.50**
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Sidetone Kit	**$ 4.95**
Sidetone Assembled	**$ 6.95**
Paddle Assembled	**$ 9.95**

MODEL 20
DIGITAL DIAL

Tune your fixed or mobile transmitter, receiver, or transceiver with 100 Hz accuracy and no last digit jitter. The Model 20 Digital Dial connects to rigs with 5-5.5 Mhz VFO's with a single wire. It can also be used as a general purpose frequency counter.

Matching accessories coming soon.

Assembled and Tested	**$169.95**
Crystal Time Base	**$ 29.95**

MODEL 31
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Monitor RF output, read power output to 1500 watts, measure SWR to 3:1, and observe RTTY and trapezoid patterns all in a single instrument! The Model 31 also includes an RF actuated CW monitor, two-tone generator, and AC and DC vertical and horizontal inputs for general purpose use.

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(or your Clegg 22'er, Poly-Comm 2, PC-62, Johnson 6N2, Aerotron 500, HA-460, TX-62 or VHF-1)

- **New! Plug-in modulator puts the Communicator transmitter on FM.**
- **No modification or rewiring on your Communicator. Just plug into mike jack and crystal socket.**
- **Compact self-contained modulator measures 4" x 3" x 1½".**
- **Works with Communicator I, II, III, IV and GC-105, and other rigs listed.**
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- **Send for free descriptive brochure.**

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RTTY SPEED CONVERTER Drilled PCB 5 & 11 VDC $40.00
DRILLED PCB ONLY $ 6.00
RTTY AFSK Gen. All Shifts & CW I.C. 9 VDC @ 7ma $6 60
100 KHz XTAL CALIBRATOR Less Xtal 9 VDC @ 2ma $4.75
100 KHz XTAL (Limited Supply) $2.50
PREAMP MICROPHONE, 26 DB Gain 9 VDC @ 1ma $3.50
LIMITER PREAMP For High Z Mike 9 VDC @ 1ma $4.80
PRODUCT DETECTOR For Your Receiver 9 VDC @ 1ma $3.60
"S" METER KIT Less 1ma Meter 6.3VAC $4.75
SWR METER, Stripline, Less 200ma Meter $2.95
WWV CONVERTER 3.5-4.0 MHz Output 9 VDC @ 5ma $5.25
Requires 6-6.5MHz Crystal
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6 OR 2 METER CASCODE PREAMP 80 VDC @ 4.5ma $4.95
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DRILLS, #54, 56, 58 or 60 (each) $.40
Finest Quality for PCB'S, Made in USA Three For $1.00

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SATISFACTION GUARANTEED. RETURN IN 30 DAYS FOR REFUND. ALL KITS POSTPAID. INCLUDE 25¢ HANDLING CHARGE. WASHINGTON RESIDENTS ADD 5% SALES TAX.

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519 SOUTH AUSTIN, SEATTLE, WASH. 98108

More Details? CHECK—OFF Page 94

CUSH-CRAFT JOINS SOLID STATE SYSTEMS

Solid State Systems, Inc. has now become an authorized distributor for Cush-Craft antennas. Call or write for price and availability.

Catalog Number	Any Quantity Per Item (Mix) 1-99	100-999	1000 up	Multiples of 10 Per Item (Mix) 100-990	1000-9990	10000 up
7400	.26	.25	.23	.22	.21	.20
7401	.26	.25	.23	.22	.21	.20
7402	.26	.25	.23	.22	.21	.20
7403	.26	.25	.23	.22	.21	.20
7404	.28	.27	.25	.24	.22	.21
7405	.28	.27	.25	.24	.22	.21
7406	.52	.50	.47	.44	.42	.39
7407	.52	.50	.47	.44	.42	.39
7408	.32	.30	.29	.27	.26	.24
7409	.32	.30	.29	.27	.26	.24
7410	.26	.25	.23	.22	.21	.20
7411	.28	.27	.25	.24	.22	.21
7413	.58	.55	.52	.49	.46	.44
7416	.52	.50	.47	.44	.42	.39
7417	.52	.50	.47	.44	.42	.39
7418	.32	.30	.29	.27	.26	.24
7420	.26	.25	.23	.22	.21	.20
7421	.26	.25	.23	.22	.21	.20
7423	.80	.76	.72	.68	.64	.60
7425	.50	.48	.45	.43	.40	.38
7426	.34	.32	.31	.29	.27	.26
7430	.26	.25	.23	.22	.21	.20
7437	.56	.53	.50	.48	.45	.42
7438	.56	.53	.50	.48	.45	.42
7440	.26	.25	.23	.22	.21	.20
7441	1.73	1.61	1.55	1.46	1.37	1.27
7442	1.27	1.21	1.14	1.07	1.01	.94
7443	1.27	1.21	1.14	1.07	1.01	.94
7444	1.27	1.21	1.14	1.07	1.01	.94
7445	1.71	1.62	1.53	1.44	1.35	1.26
7446	1.24	1.17	1.11	1.04	.98	.91
7447	1.16	1.10	1.01	.98	.92	.85
7448	1.44	1.37	1.29	1.22	1.14	1.06
7450	.26	.25	.23	.22	.21	.20
7451	.26	.25	.23	.22	.21	.20
7453	.26	.25	.23	.22	.21	.20
7454	.26	.25	.23	.22	.21	.20
7459	.26	.25	.23	.22	.21	.20
7460	.26	.25	.23	.22	.21	.20
7470	.42	.40	.38	.36	.34	.32
7472	.38	.36	.34	.32	.30	.29
7473	.50	.48	.45	.43	.40	.38
7474	.50	.48	.45	.43	.40	.38
7475	.80	.76	.72	.68	.64	.60
7476	.56	.53	.50	.48	.45	.42
7480	.76	.72	.68	.65	.61	.57
7482	.99	.94	.88	.83	.78	.73
7483	1.63	1.55	1.46	1.38	1.29	1.20
7485	1.43	1.35	1.28	1.20	1.13	1.05
7486	.58	.55	.52	.49	.46	.44
7490	.80	.76	.72	.68	.64	.60
7491	1.43	1.35	1.28	1.20	1.13	1.05
7492	.80	.76	.72	.68	.64	.60
7493	.80	.76	.72	.68	.64	.60
7494	1.18	1.12	1.05	.99	.93	.87
7495	1.18	1.12	1.05	.99	.93	.87
7496	1.18	1.12	1.05	.99	.93	.87
74107	.52	.49	.47	.44	.42	.39
74121	.56	.53	.50	.48	.45	.42
74122	.70	.67	.63	.60	.56	.53

Catalog Number	Any Quantity Per Item (Mix) 1-99	100-999	1000 up	Multiples of 10 Per Item (Mix) 100-990	1000-9990	10000 up
74123	1.21	1.06	1.00	.94	.89	.83
74141	1.63	1.55	1.46	1.38	1.29	1.20
74145	1.41	1.33	1.26	1.18	1.11	1.04
74151	1.20	1.13	1.07	1.01	.95	.88
74153	1.63	1.55	1.46	1.38	1.29	1.20
74154	2.43	2.30	2.16	2.03	1.89	1.76
74155	1.46	1.39	1.31	1.23	1.16	1.08
74156	1.46	1.39	1.31	1.23	1.16	1.08
74176	1.62	1.53	1.45	1.36	1.28	1.19
74177	1.62	1.53	1.45	1.36	1.28	1.19
74180	1.20	1.13	1.07	1.01	.95	.88
74182	1.20	1.13	1.07	1.01	.95	.88
74192	1.98	1.87	1.76	1.65	1.54	1.43
74193	1.98	1.87	1.76	1.65	1.54	1.43
74199	2.81	2.65	2.50	2.34	2.18	2.03
SCHOTTKY TTL						
74S00	.88	.84	.79	.75	.70	.66
74S01	.88	.84	.79	.75	.70	.66
74S03	.88	.84	.79	.75	.70	.66
74S04	1.00	.95	.90	.85	.80	.75
74S05	1.00	.95	.90	.85	.80	.75
74S08	.88	.84	.79	.75	.70	.66
74S09	.88	.84	.79	.75	.70	.66
74S10	.88	.84	.79	.75	.70	.66
74S15	.88	.84	.79	.75	.70	.66
74S20	.88	.84	.79	.75	.70	.66
74S22	.88	.84	.79	.75	.70	.66
74S40	1.00	.95	.90	.85	.80	.75
74S50	.88	.84	.79	.75	.70	.66
74S51	.88	.84	.79	.75	.70	.66
74S64	.88	.84	.79	.75	.70	.66
74S65	.88	.84	.79	.75	.70	.66
74S73	1.82	1.73	1.63	1.54	1.44	1.34
74S74	1.82	1.73	1.63	1.54	1.44	1.34
74S112	1.82	1.73	1.63	1.54	1.44	1.34
74S114	1.82	1.73	1.63	1.54	1.44	1.34
74S140	1.00	.95	.90	.85	.80	.75
LINEAR IC'S						
NE501	2.99	2.82	2.66	2.49	2.32	2.16
NE526	3.59	3.38	3.17	2.95	2.74	2.53
NE536	7.31	6.88	6.45	6.02	5.59	5.16
NE537	7.53	7.09	6.65	6.20	5.76	5.32
SE540	4.48	4.20	3.92	3.64	3.36	3.08
NE560	3.57	3.36	3.15	2.94	2.73	2.52
NE561	3.57	3.36	3.15	2.94	2.73	2.52
NE562	3.57	3.36	3.15	2.94	2.73	2.52
NE566	3.57	3.36	3.15	2.94	2.73	2.52
N5111	.90	.86	.81	.77	.72	.68
N5558	.80	.76	.72	.68	.64	.60
N5595	3.40	3.20	3.00	2.80	2.60	2.40
N5596	1.87	1.77	1.66	1.56	1.46	1.35
709	.42	.40	.38	.36	.34	.32
710	.42	.40	.38	.36	.34	.32
711	.44	.42	.40	.37	.35	.33
723	1.00	.95	.90	.85	.80	.75
733	1.90	1.80	1.70	1.60	1.50	1.40
741	.44	.42	.40	.37	.35	.33
748	.48	.46	.43	.41	.38	.36

TRANSISTORS & DIODES

1N270	.15	.14	.13	.12	.11	.10
1N751A	.30	.28	.26	.24	.22	.20
1N914	.10	.09	.08	.07	.06	.05
1N4001	.10	.09	.08	.07	.06	.05
1N4002	.11	.10	.09	.08	.07	.06
1N4003	.13	.12	.11	.10	.09	.08
1N4006	.15	.14	.13	.12	.11	.10
1N4154	.15	.14	.13	.12	.11	.10
2N3860	.25	.23	.21	.19	.17	.15

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220 µF, 15V	15¢	5 µF, 50V	10¢
500 µF, 15V	20¢	10 µF, 50V	15¢
1000 µF, 15V	30¢	20 µF, 50V	20¢
20 µF, 25V	15¢	50 µF, 50V	20¢
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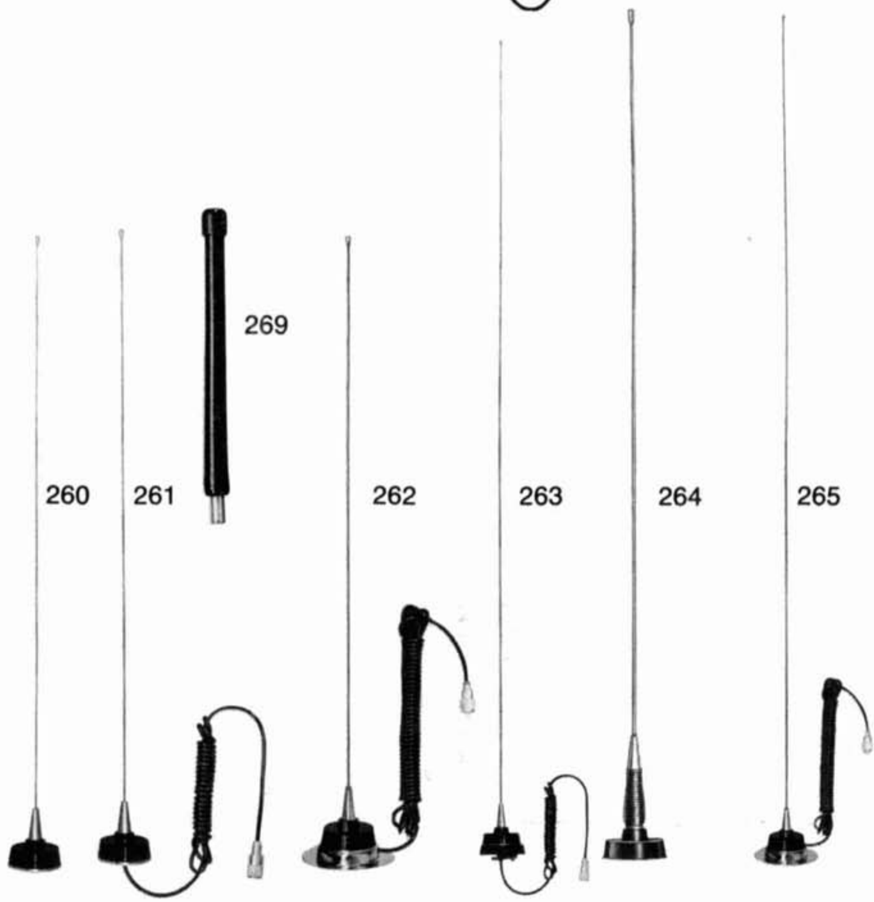

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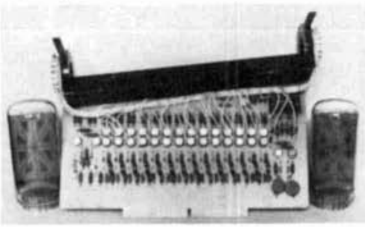

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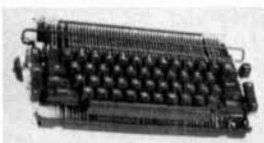

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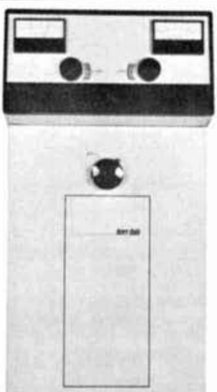

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- Bandpass coupled transmitter requiring only final tune and load
- Three internal transmit crystal sockets with trimmers for netting
- One transmitter crystal socket on the front panel
- Deviation limiting
- 146.94 MHz crystal included

RECEIVER:

- Double conversion
- Crystal controlled first conversion
- MOS FET receiver front-end
- Integrated circuit limiter and discriminator for FM
- Envelope detector and series gate noise clipper for AM
- Built-in squelch for both AM and FM

GENERAL:

- Separate transmitter and receiver tuning
- Built-in 115VAC power supply
- Direct 12VDC operation for mobile or portable operation
- Optional portable rechargeable snap-on battery pack available
- "S" Meter also used for transmitter tune up
- Military style glass epoxy circuit boards
- Anodized lettering and front panel
- Baked epoxy finish on the cabinet
- 47 transistors, 22 diodes, 1 integrated circuit
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A small signal amplifier to drive MXX-1 mixer. Single tuned input and link output. Lo Kit 3 to 20 MHz, Hi Kit 20 to 170 MHz (Specify when ordering) **$3.50**

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More Details? CHECK—OFF Page 94

Amateur FM Comes of Age

- Number of Channels: 12 channel capability for transmit and receive
- RF Power Output: 10 Watts or 3 Watts.
- Audio Output: 2 Watts minimum w/internal speaker (at less than 10% distortion)
- The price: $329.00 w/out power supply

TEMPO/CL 146

- Frequency Range: 146-148 MHz
- Same general specifications as CL 220
- The price: $279.00

TEMPO/CL 220

As new as tomorrow! The Tempo Commercial Line VHF transceivers offer commercial performance at amateur prices. Both units include an audio limiter to assure constant deviation at all times and an instantaneous impulse squelch. Microphone, power cord, mounting bracket and one pair of crystals is included.

- Frequency Range: 220-225 MHz (2 MHz operating range)

TEMPO/fmp

Truly mobile, the Tempo/fmp 2 meter 3 watt portable gives amateurs 3 watts, or a battery saving ½ watt, FM talk power anyplace at anytime. With a leather carrying case included, this little transceiver will operate in the field, in a car, or at home with an accessory AC power supply. The battery pack is included. The price: $225.00 (Accessory rechargeable battery available: $22.00)

TEMPO/fmv 2

So much for so little! This little 10 Watt VHF FM transceiver offers high quality performance and features usually found only on more expensive units. Features such as AFC on receive and separate switchable Transmit/Receive sections. Includes mounting bracket, heavy duty power cord and provisions for accessory AC power supply. Frequency: 146-148 MHz, 11 channels, 25 KHz channel spacing. 13.8 VDC ±10% operation (standby −100 ma, receive −150 ma, transmit−3.0 amp.) $199.00

TEMPO/TPL high power fm amplifiers

MODEL NUMBER	POWER INPUT	POWER OUTPUT (min)	BAND	PRICE
TPL1002-3	5 to 25W	100-135W	2M	$220.00
TPL1002-3B	1-3W	80W	2M	$235.00
TPL802	5W	80W	2M	$180.00
TPL802B	1 to 3W	80W	2M	$195.00
TPL502	5 to 15W	35-55W	2M	$105.00
TPL502B	1 to 3W	45W	2M	$130.00
TPL252-A2	1W	25W	2M	$ 85.00
TPL445-10	1 to 2.5W	12W	440MHz	$125.00
TPL445-30	4W	30W	440MHz	$215.00
TPL445-30B	1W	30W	440MHz	$235.00

TCP 12A Control Head . . . $32.00

TEMPO/fmh

So much for so little! 2 watt VHF/FM hand held. 6 Channel capability, solid state, 12 VDC, 144-148 MHz (any two MHz), includes 1 pair of crystals, built-in charging terminals for ni-cad cells, S-meter, battery level meter, telescoping whip antenna, internal speaker & microphone. $189.00

TEMPO/6N2

The Tempo 6N2 meets the demand for a high power six meter and two meter power amplifier. Using a pair of Eimac 8874 tubes it provides 2000 watts PEP input on SSB and 1000 watts input on CW and FM. Completely self-contained in one small desk mount cabinet with internal solid state power supply, built in blower and RF relative power indicator.

Prices subject to change without notice.

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The no-compromise Alpha 77 is powered by the no-compromise EIMAC 8877.

No corners were cut in designing the rugged Alpha 77 amplifier. Rated for continuous commercial service, it loafs along at the maximum legal amateur power limit.

And, no corners were cut in designing EIMAC's air-cooled 8877 ceramic/metal, high-mu triode, the Alpha 77 power tube. The 8877 is conservatively rated at 1500 watts plate dissipation up to 250 MHz and requires less than 65 watts PEP drive signal for the legal power input limit. This impressive power gain is achieved with 3rd order intermodulation distortion products −38 decibels below one tone of a two equal-tone drive signal.

This compact, rugged, high-mu power triode has a maximum plate voltage rating of 4000 and a maximum plate current rating of one ampere in commercial service. While the 8877 is primarily designed for superlative linear amplifier service demanding low intermodulation distortion, its high efficiency also permits excellent operation as a class C power amplifier, oscillator, or as a plate modulated amplifier. The zero bias characteristic is useful for these services, as plate dissipation is held to a safe level if drive power fails, up to a plate potential of 3 kV.

The Alpha 77 is the ultimate power amplifier for the 70's. That's proven by the choice of the 8877, another example of EIMAC's ability to provide tomorrow's tubes today. For additional information on this tube or other products, contact EIMAC Division of Varian, 301 Industrial Way, San Carlos, California 94070. Phone (415) 592-1221. Or contact any of the more than 30 Varian/EIMAC Electron Tube and Device Group Sales Offices throughout the world.

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